C-11653
Quarterly Progress Report #1
(May - July, 2003)

Land Application of Residuals and Chicken Manure in the Lake Okeechobee Watershed: Phosphorus Considerations

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A. CONSTRUCTION

Construction of the demonstration project was completed on July 30, 2002. The resulting demonstration project infrastructure is composed of 51, half-acre plots arranged in three blocks of 17 plots each as shown in Figure A1.

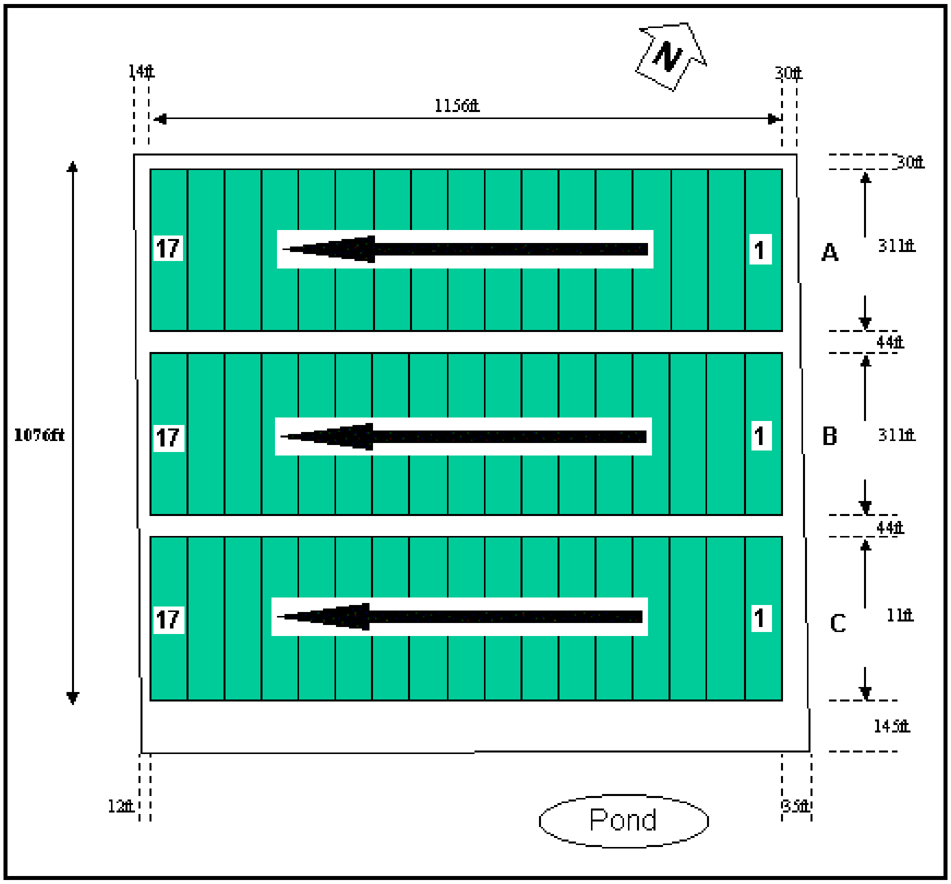

Figure A1. Project site schematic.

The construction process for the Kirton Ranch Project included:

? Sampler design and testing
? Sampler parts and fabrication
? Controller design
? Controller parts and fabrication
? Site preliminary soil sampling
? Site surveying and design
? Ditch system development and installation
? Transporting 52 samplers to site
? Sampler installation
? Drilling equipment acquisition and repairs
? Well drilling
? Telemetry and database

Survey

Kirton Ranch is located at 5651 NE 80th Ave Okeechobee, FL, 34972-8118. The coordinates of the ranch are 27° 18' 36" N / 80° 44' 36". The dimensions of the site was determined by considering land availability, ditch and berm requirements, as well as runoff variability, roadways, harvesting, residual application patterns and costs. The site consists of three parallel blocks (1156 ft x 311 ft) with each block containing 17 equal size plots (68 ft x 311 ft), as shown in Figure A1. A fence surrounds the site to prevent cattle and wild hog invasion. Surveys were completed to locate origin and axes on the site, to examine the topography and to collect data for elevations and slope values. The ground water wells in each plot are marked with survey flags. The final geometric dimensions of the site are shown in Figure A1.

Fence

A hog-proof fence as shown in Figure A2 is used to prevent the access of cattle or hogs into the project site (so as to prevent damage to the samplers and collection ditches).

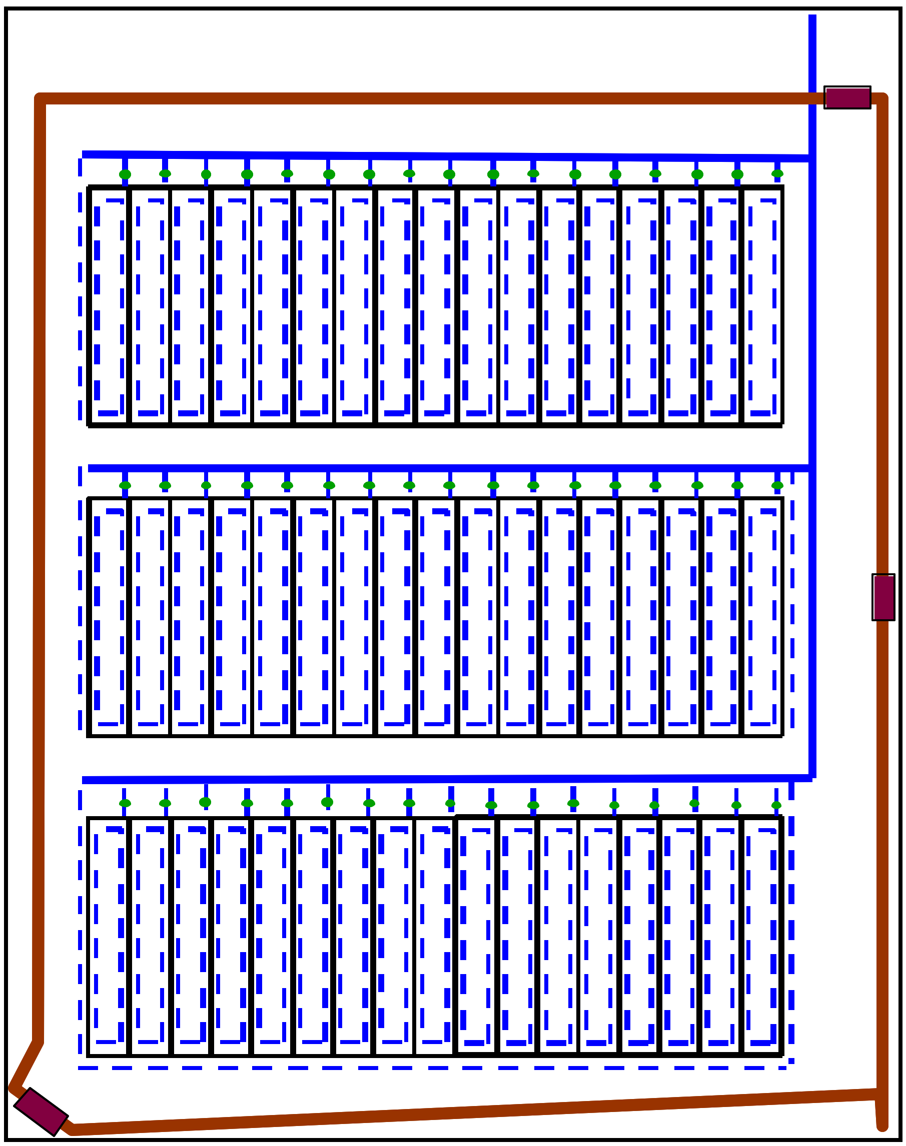

Figure A2. Location of perimeter fence and gates.

Ground Water Wells

The ground water sampling at Kirton Ranch is performed in both shallow and deep groundwater wells, Figure A3. Each experiment plot contains 2 wells positioned 4 ft apart, with both located in the middle of the demonstration plots (approximately 155.5 ft from the flume), as shown in Figure A3.

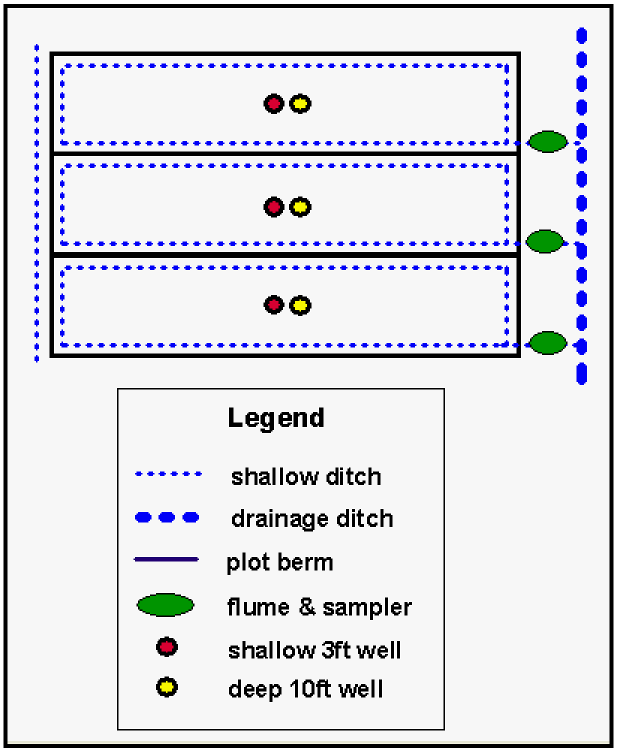

Figure A3. Layout of plots and measurement locations.

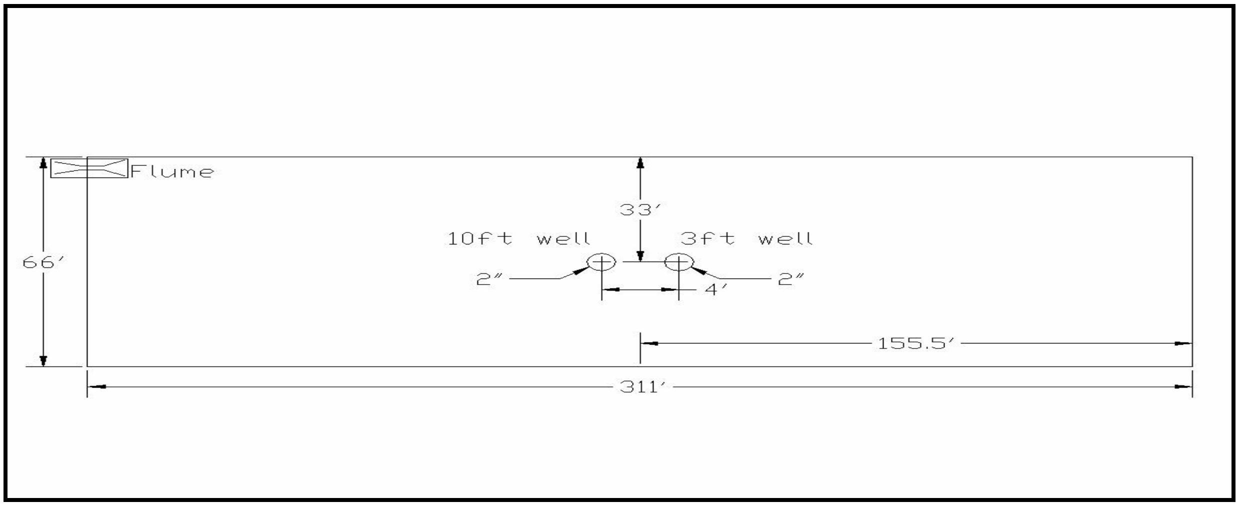

Figure A4. Well locations within each plot.

The wells were installed on each experimental plot using a hollow-stem rotary auger system. Appropriate sands backfill was used over the screen length to minimize the introduction of sediments into the wells and water samples. The wells are of 2 inch diameter PVC construction with a casing diameter of 8 inches, Figure A5. Depths for the two wells as specified by SFWMD are 3 ft and 10 ft (separated by the first spodic horizon), with corresponding screen lengths of 1.5 and 5 ft respectively. The deeper wells allow samples to be taken all year round particularly when the water table falls to it's lowest during winter.

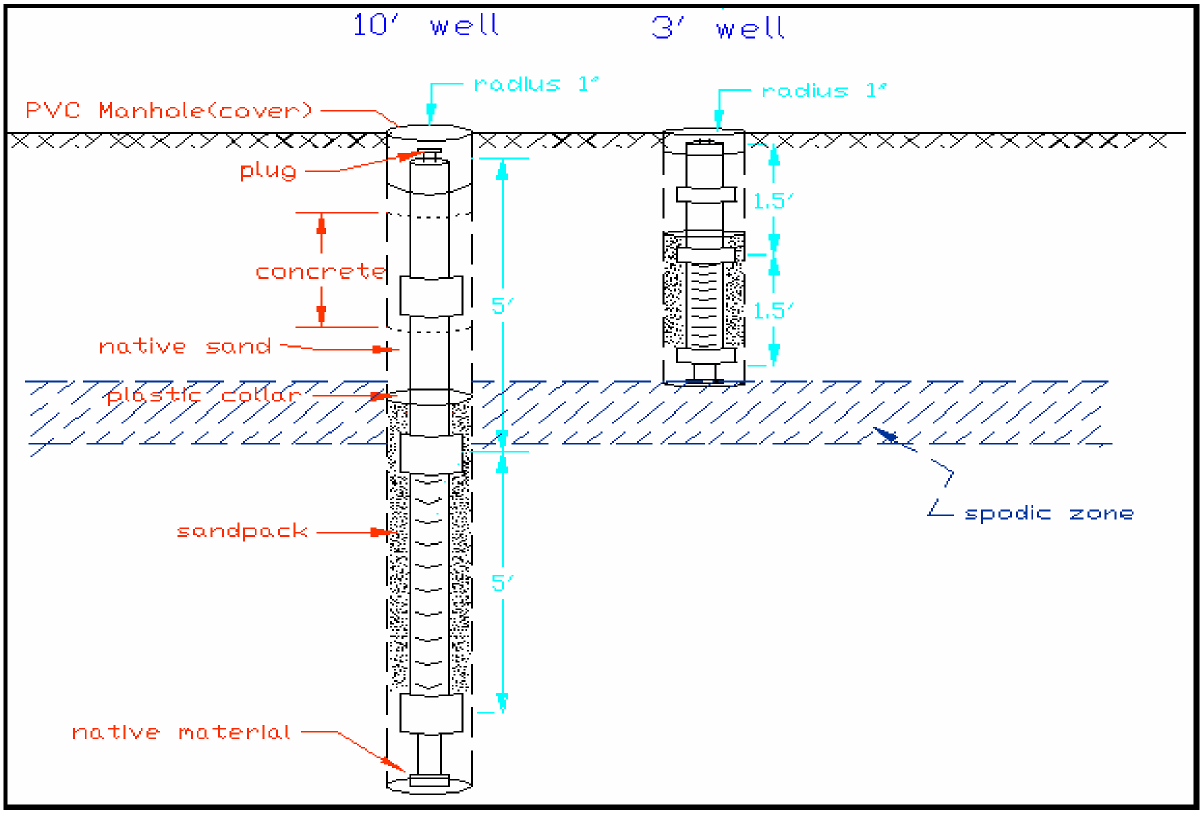

Figure A5. Wells construction schematic.

Groundwater measurements at Kirton Ranch include both measurements of water table depths and quality of the groundwater (Total Phosphorus concentration). These measurements have been taken in-situ via grab samples during random times of high rainfall. The in-situ groundwater sampling is performed in accordance with the Department of Environment and Protection's standard operating procedures, FS 2200. This was instigated to ensure the samples integrity by minimizing the likelihood of sampling and handling contaminations.

Ditches

The ditch system at Kirton Ranch collects the runoff water from each plot, carries it to the water sampling system and then evacuates it without causing backwater conditions in the Parshall flumes. The water collection system includes berms so that each plot constitutes a separate drainage parcel and the water from each plot can be measured and analyzed separately.

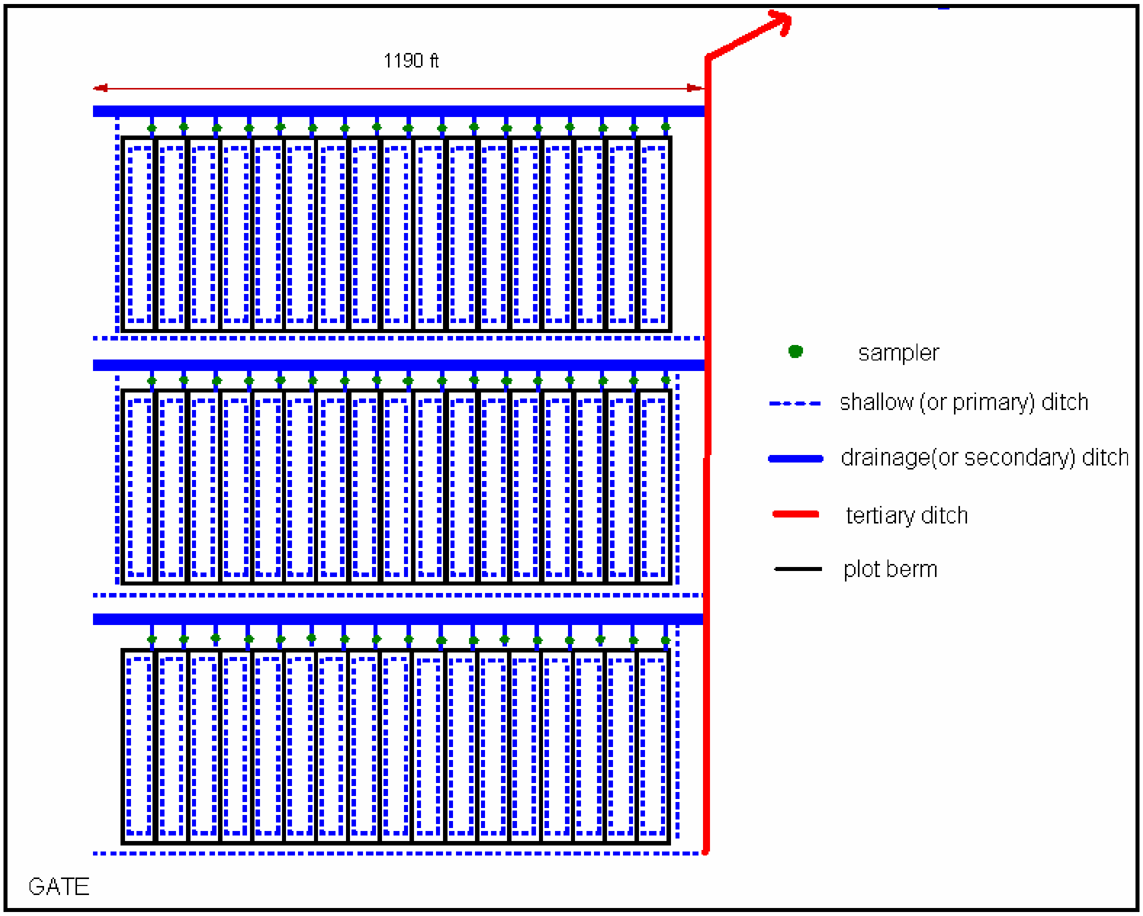

Figure A6. Project Site Drainage System.

The project site at Kirton Ranch is made up of three different ditch collection systems. The primary or shallow ditches collect the water from one plot and bring it to the sampler (see Figure A7). The perimeter ditches are 10 inches deep and 20 inches wide. The secondary drainage ditches collect discharge water from each of the three blocks. The dimensions of these ditches are shown in Figure A8. The tertiary drainage ditches will evacuate the water from the three secondary ditches and bring the water out of the project site. This one main ditch has dimensions shown in Figure A9 and is slightly larger than the secondary ditches.

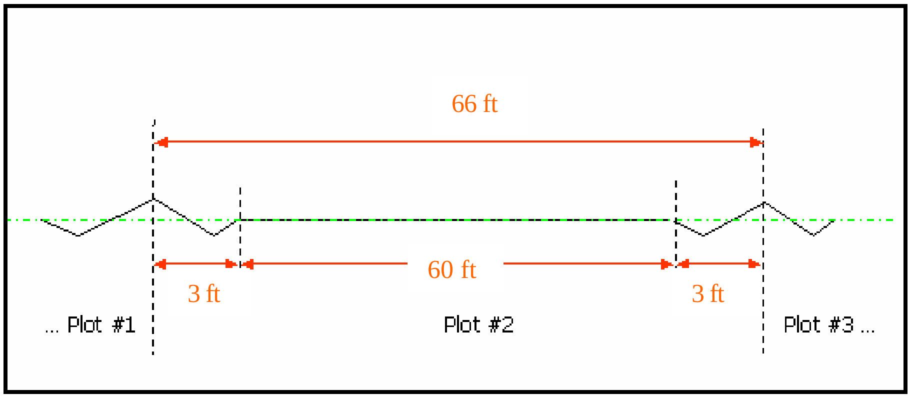

Figure A7. Section of a plot.

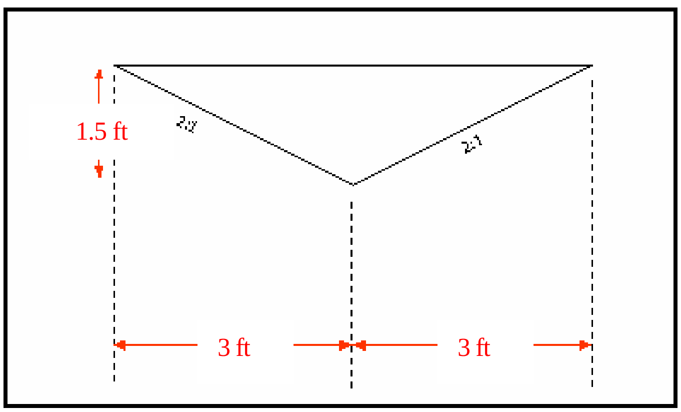

Figure A8. Secondary ditch section.

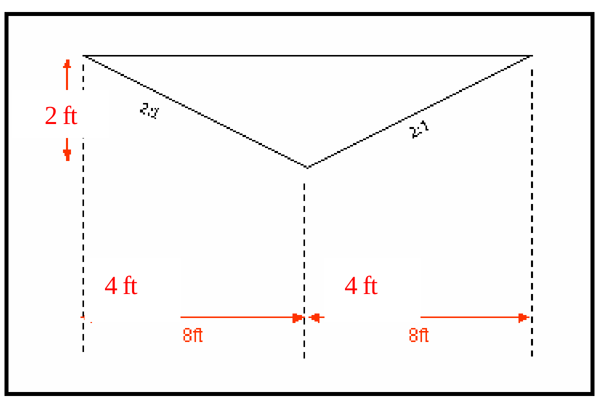

Figure A9. Tertiary ditch section.

Samplers

The surface water sampling systems at Kirton Ranch consist of a Parshall flume, automatic water sampler, electronic controller/datalogger, solar panel, battery, and telemetry system, as shown in Figure A10. The concept was to create a sampler that would collect a flow-weighted composite sample while also allowing measurement of discrete hydrograph data via a real-time telemetry system without using expensive water level sensors and data processors. The samplers deployed at Kirton Ranch meet those functional objectives. Schematic diagrams and photos of the samplers are shown in Figures A10 through A13.

After the initial design and prototype field testing, the new samplers were rushed into production so that 51 units could be deployed for the project. The production of these machines consumed an average of one week's time per unit. Fabrication was completed in early 2002 and the samplers were installed at the field site in the spring of 2002. During the summer of 2002, three extra samplers were transported to the University of Florida where they were subject to laboratory testing at the Department of Agricultural and Biological Engineering (see Figure A14). These tests documented several reliability problems, particularly with the float trigger system. This component was subsequently redesigned and all 51 samplers were retrofitted with the new switch systems. The lab tests pointed out several other functional improvements that would improve the reliability of the system. The tests did conclude that when properly maintained, the units would deliver accurate hydrographs and composite water samples. The flumes were designed and laboratory tested to ensure that they demonstrated enough accuracy and reliability. The laboratory testing and the experience gained through a year of field maintenance of these machines has pointed out several opportunities for design modification and performance improvements. These changes will be made to the 51 samplers as time and funds permit.

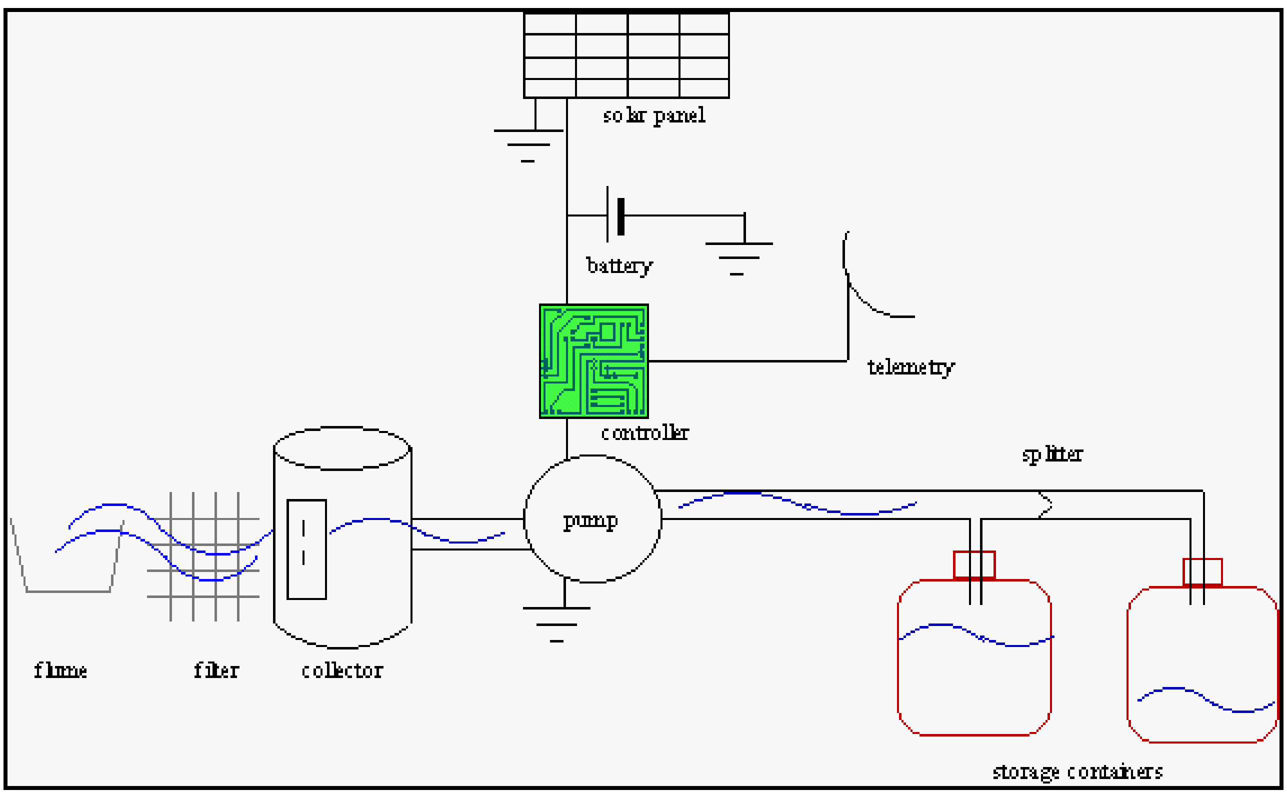

Figure A10. Surface water collection system schematic.

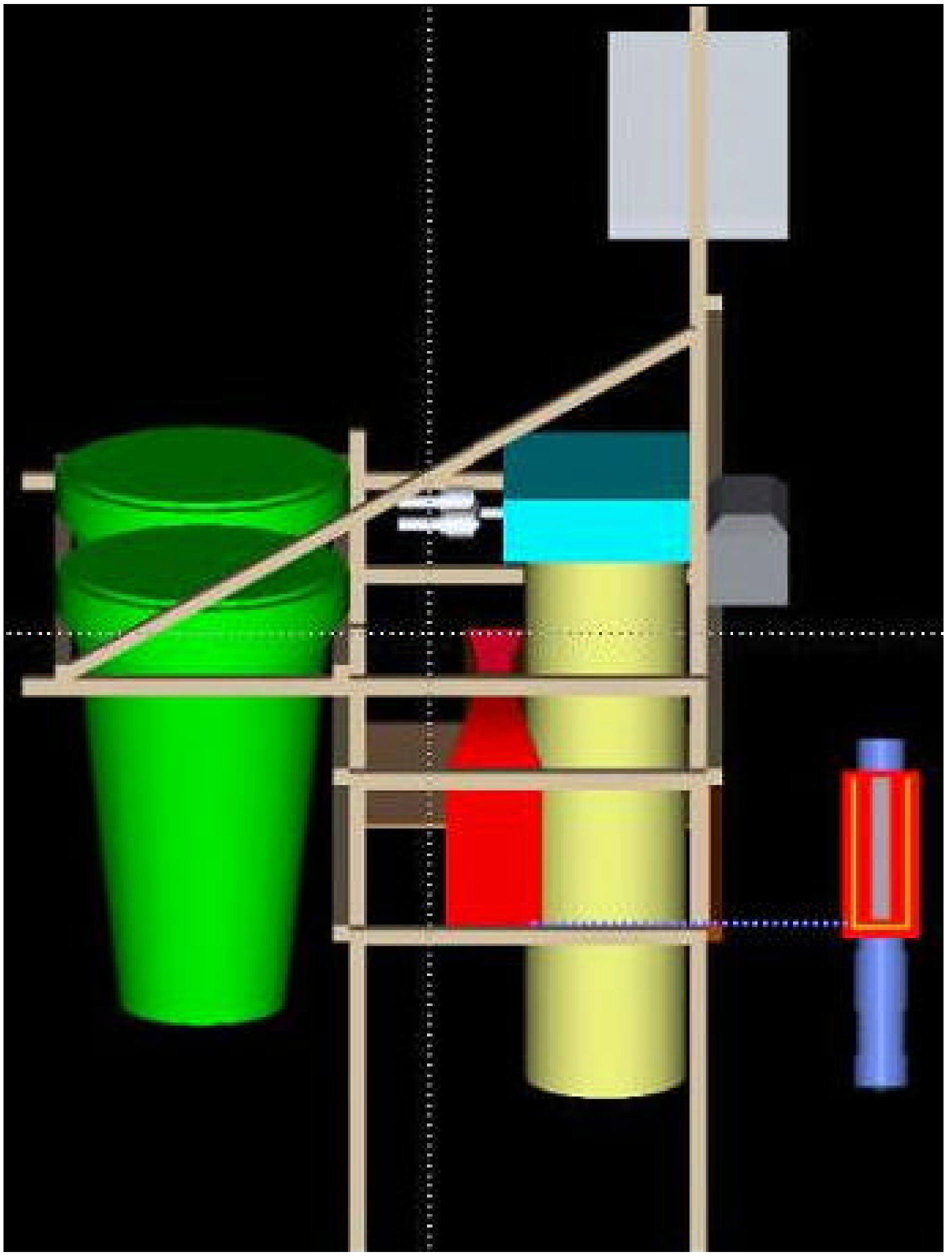

Figure A11. Tail water view of the water sampler, including a rendition of the sampling chamber core.

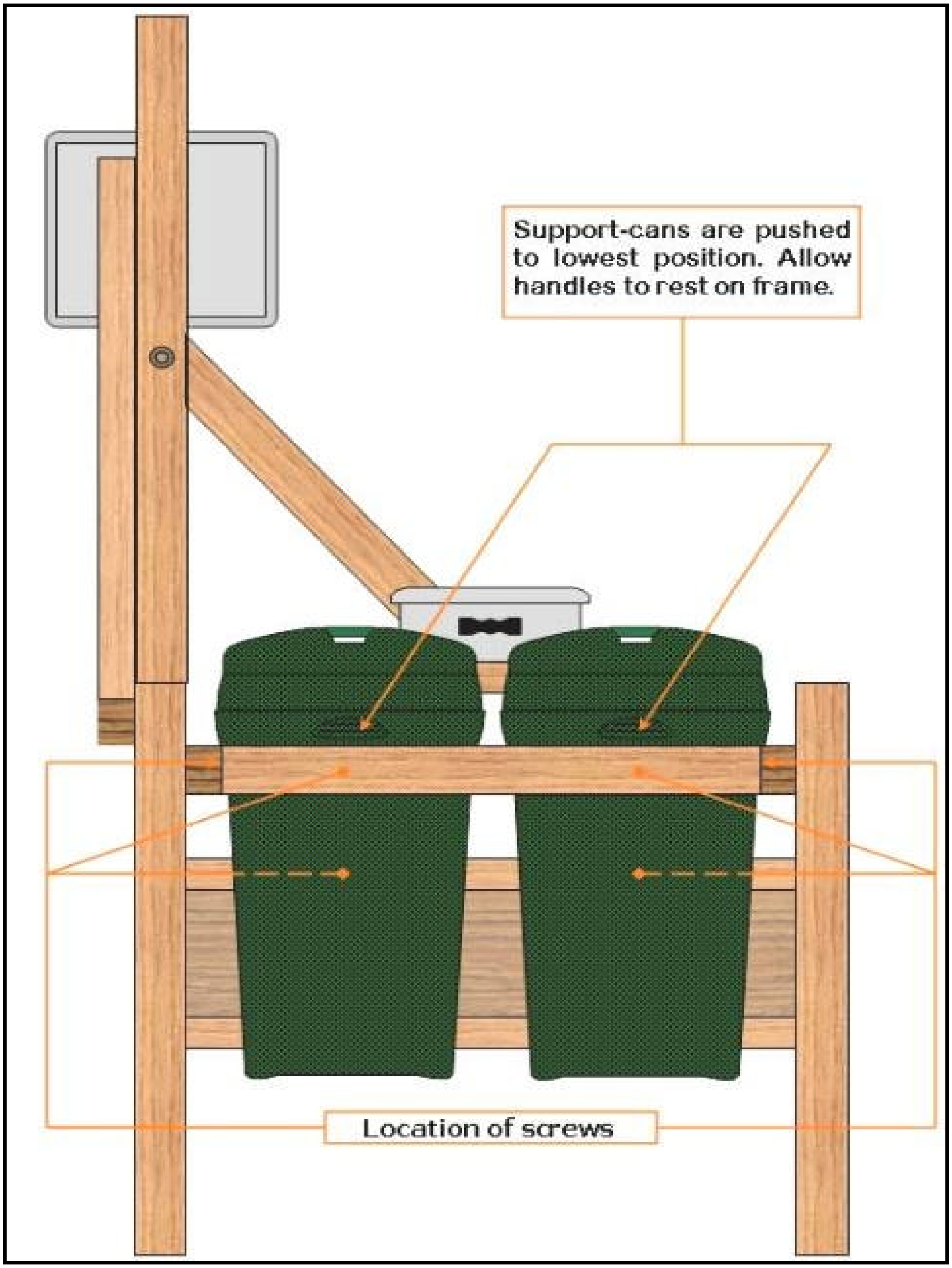

Figure A12. Side view of the automatic water sampler, showing the two sample bottle storage bins.

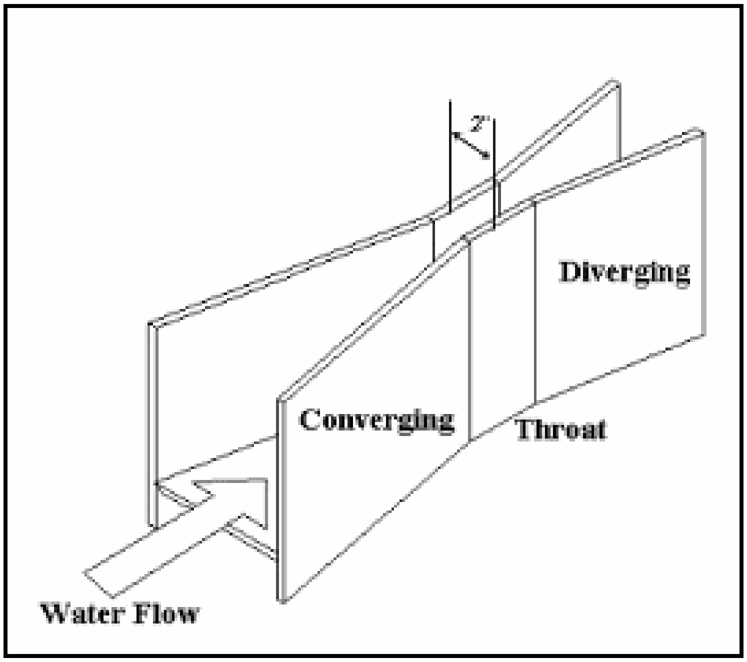

Figure A13. Schematic of the Parshall flume design used for the Kirton Ranch water samplers.

Figure A14. Testing of surface water sampling system at University of Florida.

Figure A15. One of the three rows of surface water samplers installed at Kirton Ranch.

B. TREATMENTS

The land application of materials at the Kirton Ranch field for the C-11653 project was completed on May 27, 2003. The process of materials land application at the Kirton Ranch field site consisted of six steps:

1. Secure permits from DEP (see approved permit in appendix)
2. Finalize design and treatments
3. Complete planning and costs determination
4. Order and schedule materials delivery
5. On-site storage and staging of materials
6. Application of materials

The Design Implementation Report (November 8, 2002) facilitated completion of steps 1 and 2. Step 3 involved the coordination of all deliveries so that all materials were available when needed. Step 4 required identifying a proper place for storage of the delivered materials. The selected storage location satisfied the following criteria:

- ? Dry storage space
- ? Near to the Kirton Ranch field plots
- ? Level grade for safety of dump trucks
- ? Easy access for workers
- ? Easy access by front end loader
- ? Easy access for delivery trucks

A Southern DataStream representative was on site during delivery of materials to verify quantity as well as quality and to direct trucks to the proper storage location. Once all deliveries were made, the final step of this operation was the land application of the materials to the plots. Southern DataStream's staff monitored this phase to verify that the proper amounts of each material were applied to the plots. Samples of all applied materials were delivered to UF/IFAS laboratories for analysis of moisture content to finalize the rate calculations immediately prior to field application.

Materials and Equipment

A discussion among project participants proposed to apply the following materials:

1. Chicken Manure (from Tampa Farms in Indiantown)
2. WWTP Residuals (biosolids) from Boca Raton
3. WWTP Residuals (biosolids) from Pompano Beach
4. WTP Residuals (alum) from Manatee County
5. Commercial fertilizer: Triple Super Phosphate
6. Commercial fertilizer: Ammonium Nitrate.

Three types of machines were needed for this operation and the application of all materials was performed by one contractor, Bridges Applications. The machines used included a manure spreader, a front-end loader, and a fertilizer spreader. The materials were transported to the field site from the source plants by the designated hauling company for each materials provider, with the exception of the alum material, which was transported by Sweetwater Environmental of Okeechobee.

Selection of Biosolids and Rates

The two biosolids chosen for this project represent both a "low-soluble P" source and a "high-soluble P" source, i.e. they represent both ends of the spectrum with regard to what might be land-applied. The Boca Raton material was originally selected based on its high P solubility. In the redesign of the experiment, a low-solubility material was also wanted as a treatment. The Pompano characterization data dictated that it was the best source from among the other four sampled when analyzed during the characterization process. The rates of biosolids application were calculated starting with the agronomic rates requirements of the bahiagrass hay field, 80 lbs/acre P2O5 and 160 lbs/acre N. The N and P percentages and the percent solids of the biosolids, as reported in the materials characterization reports, were used to determine the quantities of actual biosolids required. Assumptions of 100% bioavailability of P and 50% bioavailability for N were used in the treatment formulation as advised by UF/IFAS scientists, Dr. Obreza and Dr. O'Connor. These calculations are shown in the appendix. The 50% N bioavailability assumption is based upon DEP standard methodology. The 100% P bioavailability assumption is a working value based upon results of green house studies by Dr. O'Connor.

Selection of Poultry Waste and Rates

The options to obtain poultry waste were limited. While there is a poultry facility adjacent to Kirton Ranch which currently supplies materials to the property, Tampa Farms in Indiantown was specifically designated by SFWMD as the material source for this project. Tampa Farms in Indiantown trucks tons of material out per day, thus it is representative of what a large egg-laying operation produces for land application. The rates of poultry waste application were calculated starting with the agronomic rates requirements of the crop, 80 lbs/acre P2O5 and 160 lbs/acre N. The N and P percentages and the percent solids of the poultry waste, as reported in the materials characterization reports, were used to determine the quantities of actual material required.

Selection of WTR and Rates

The WTR material was chosen based on its potential P-sorbing property and its use in other research projects. Again, the data supporting this selection is presented in the characterization report. Dr. O'Connor had previously evaluated a number of WTRs and he recommended the Bradenton source because a) they have a large volume of material in storage, and b) it has favorable chemical properties regarding P sorption. Other materials were available at lower costs, but the Bradenton County material was specified in an effort to select a material being used by Dr. O'Connor in other projects. Dr. O'Connor serves as a project advisor assisting the UF-IFAS P.I., Dr. Obreza.

Dr. O'Connor's greenhouse studies used a 2.5% application rate, calculated on an acre furrow slice rate basis. He showed that this rate was able to essentially stop P loss from soils with a low natural capacity to sorb P. While the WTR material contains 5.6 g/kg total phosphorous, the prior studies using this material (documented in the C-11653 characterization report) show that this P content is not soluble and the material is a net sink for additional P. In the greenhouse study, the material was actually incorporated into the soil profile. However, realistic field application methods would not allow this incorporation. Therefore, the application rate for purposes of the field experiment has been reduced to 1% to avoid placing an excessively large amount of material directly on the soil surface. Additional laboratory work with the WTR at Penn State University (Dr. Chip Elliott) has shown that P losses from soil when a 1% rate was applied were only slightly higher than that observed with a 2.5% application rate.

Selection of Standard Fertilizers and Rates

The materials chosen were typical of what is applied to Florida crops (ammonium nitrate and concentrated superphosphate). TSP means Triple SuperPhosphate (0-46-0). The fertilizer treatments were proposed as:

- 3 reps of: 160 N, 80 P2O5, WTR-yes
- 3 reps of: 160 N, 80 P2O5, WTR-no
- 3 reps of: 160 N, 260 P2O5, WTR-yes
- 3 reps of: 160 N, 260 P2O5, WTR-no.

The 80 lbs/ac rate for application of P2O5 commercial fertilizer represents the IFAS recommended rate for bahiagrass hay field. The plots receiving this fertilizer rate represent the P-based rate treatments. Similarly, the 160 lbs/ac of N represents the IFAS recommended fertilization rate. Thus, the 160-80 treatments match standard commercial fertilizers application rates for bahiagrass hay fields. The 260 lbs/acre P2O5 rate was selected to better match the rate of P applied by the biosolids and manure treatments. The N-based Boca treatment will apply 357 lbs P2O5/acre, N-based Pompano will apply 251 lbs P2O5/acre, and N-based Poultry manure will apply 166 lbs P2O5/acre. The most viable treatment option is to use a representative rate of 260 lbs/acre. The scientific rationale for applying excess phosphorus to these plots is to allow direct comparison of water quality responses from the standard fertilizer P source and comparable quantities of P applied through the manure and residuals treatments. This approach will also allow more direct comparison of the agronomic (yield) effects from the various P sources.

It was also determined that in all treatments the calculations should be based on the effective application area rather than the full plot area. Since each 0.5-acre plot has a perimeter margin that includes the ditches/berm areas and a grassed buffer zone, the effective treatment area is 0.35 acres. The commercial fertilizer treatments of N and P will be applied in separate passes to avoid the complications of mixing formulations done in small quantities by fertilizer contractors.

Potassium will not be applied to the plots given that bahiagrass response to K is small. The amount of K applied with biosolids and manure is miniscule. The K leaves the animal/human system via the liquid stage and does not accumulate in the solids. The nitrogen fertilizer was applied as a partial treatment of 50 lbs per plot. Application of more than that would have damaged the grass. The remainder of the fertilizer treatment will be applied after the first hay harvest.

Material Quantities

Tables B1 to B3 show the materials and quantities applied to rows A, B, and C. The only deviation from the planned plot layout was the switching of the B1 and B13 treatments. B13 is now the control plot for the B block.

Table B1. Row A material types and quantity distribution.

Row A Plot ID		Material Type All quantities are given in US tons, wet weight									
Relative System	**Absolute System**	**C-N**	**C-P**	**B1-N**	**B1-P**	**B2-N**	**B2-P**	**T-N**	**T-P**	**A**	**N**
A 01	**1**	0	1.19	0	0	0	0	0	0	8.54	0.025
A 02	**2**	0	0	5.22	0	0	0	0	0	8.54	0
A 03	**3**	0	0	0	0	0	0	0	0.030	8.54	0.025
A 04	**4**	0	0	0	0	5.19	0	0	0	8.54	0
A 05	**5**	0	1.19	0	0	0	0	0	0	0	0.025
A 06	**6**	0	0	5.22	0	0	0	0	0	0	0
A 07	**7**	0	0	0	0	0	1.65	0	0	8.54	0.025
A 08	**8**	0	0	0	0	0	0	0	0.030	0	0.025
A 09	**9**	2.47	0	0	0	0	0	0	0	8.54	0
A 10	**10**	0	0	0	0	0	1.65	0	0	0	0.025
A 11	**11**	0	0	0	0	0	0	0.099	0	8.54	0.025
A 12	**12**	2.47	0	0	0	0	0	0	0	0	0
A 13	**13**	0	0	0	1.17	0	0	0	0	8.54	0.025
A 14	**14**	0	0	0	1.17	0	0	0	0	0	0.025
A 15	**15**	0	0	0	0	0	0	0.099	0	0	0.025
A 16	**16**	0	0	0	0	5.19	0	0	0	0	0
A 17	**17**	**Absolute Control**									
Row A total quantity		**4.94**	**2.38**	**10.45**	**2.34**	**10.39**	**3.31**	**0.20**	**0.06**	**68.29**	**0.25**

Table B2. Row B material types and quantity distribution.

Row B Plot ID		Material Type All quantities are given in US tons, wet weight									
Relative System	Absolute System	C-N	C-P	B1-N	B1-P	B2-N	B2-P	T-N	T-P	A	N
B 01	18	0	1.19	0	0	0	0	0	0	8.54	0.025
B 02	19	0	0	0	0	5.19	0	0	0	8.54	0
B 03	20	0	0	0	0	0	0	0	0.030	8.54	0.025
B 04	21	0	0	5.22	0	0	0	0	0	8.54	0
B 05	22	2.47	0	0	0	0	0	0	0	8.54	0
B 06	23	0	0	0	0	0	1.65	0	0	8.54	0.025
B 07	24	0	0	0	1.17	0	0	0	0	8.54	0.025
B 08	25	0	0	0	0	0	1.65	0	0	0	0.025
B 09	26	0	0	0	0	0	0	0.099	0	8.54	0.025
B 10	27	0	0	5.22	0	0	0	0	0	0	0
B 11	28	0	0	0	0	0	0	0	0.030	0	0.025
B 12	29	0	0	0	0	5.19	0	0	0	0	0
B 13	30	Absolute Control									
B 14	31	0	0	0	1.17	0	0	0	0	0	0.025
B 15	32	0	1.19	0	0	0	0	0	0	0	0.025
B 16	33	0	0	0	0	0	0	0.099	0	0	0.025
B 17	34	2.47	0	0	0	0	0	0	0	0	0
Row B total quantity		**4.94**	**2.38**	**10.45**	**2.34**	**10.39**	**3.31**	**0.20**	**0.06**	**68.29**	**0.25**

Table B3. Row C types and quantity distribution.

Row C Plot ID		Material Type All quantities are given in US tons, wet weight									
Relative System	Absolute System	C-N	C-P	B1-N	B1-P	B2-N	B2-P	T-N	T-P	A	N
C 01	35	0	0	0	1.17	0	0	0	0	8.54	0.025
C 02	36	0	0	0	0	0	1.65	0	0	8.54	0.025
C 03	37	0	1.19	0	0	0	0	0	0	8.54	0.025
C 04	38	0	0	0	0	0	1.65	0	0	0	0.025
C 05	39	0	0	0	1.17	0	0	0	0	0	0.025
C 06	40	0	1.19	0	0	0	0	0	0	0	0.025
C 07	41	0	0	5.22	0	0	0	0	0	8.54	0
C 08	42	0	0	0	0	0	0	0	0.030	8.54	0.025
C 09	43	0	0	0	0	5.19	0	0	0	8.54	0
C 10	44	2.47	0	0	0	0	0	0	0	8.54	0
C 11	45	0	0	0	0	0	0	0	0.030	0	0.025
C 12	46	0	0	5.22	0	0	0	0	0	0	0
C 13	47	0	0	0	0	0	0	0.099	0	8.54	0.025
C 14	48	2.47	0	0	0	0	0	0	0	0	0
C 15	49	0	0	0	0	0	0	0.099	0	0	0.025
C 16	50	0	0	0	0	5.19	0	0	0	0	0
C 17	51	Absolute Control									
Row C total quantity		**4.94**	**2.38**	**10.45**	**2.34**	**10.39**	**3.31**	**0.20**	**0.06**	**68.29**	**0.25**

C. GROUND WATER

Measurement of ground water quality commenced in February 2003. This first set of samples were, however, not analyzed since the IFAS laboratory was not prepared to accept samples from this project prior to April, 2003. These initial samples were discarded and a new set of samples collected on March 19, 2003. Approximately 2 weeks after completion of materials application, another set of ground water samples were collected on June 13. Additional samples were collected on June 17 and July 13. Each future monthly sampling of ground water wells will be scheduled for the second or third week of the month.

The collected samples were analyzed for the OPO4, TDPO4 and Total Aluminum. Results of these tests are provided in Figures C1 through C5 and in Tables C1 through C5. Electrical conductivity, pH, temperature and water table depth measurements were also taken at the time of well sampling. These results are provided in the appendices.

Comparison of the chemistry results for the various sets of ground water samples show clear water quality differences between the plots. In general, the A row wells demonstrated the highest concentrations while the B and C rows had lower concentrations. It is premature to begin attempting to relate these concentration measurements to treatment differences. Such comparisons will begin in the second quarter of the project sampling. The conclusion that can be drawn is that very high plot to plot variability in ground water quality is apparent in this project site and will complicate attempts to observe treatment effects in ground water. It will be interesting to see how the surface water quality results compare with the ground water results. Since no surface water samples were collected prior to treatment implementation, only the ground water results will provide an indication of pre-treatment background concentrations of phosphorus and aluminum.

Bottoms of the shallow wells are 3 feet below land surface while the deeper wells extend to a depth of 10 feet. The shallow wells were sampled twice (March 19, June 24) while the deeper wells were sampled on four dates (March 19, June 13, June, 27 and July 17). The occurrence of water in all the shallow wells happened infrequently during the first sampling quarter. Another problem occurred with the June 24 sample set. Unfortunately, the shallow well samples taken on this date were accidentally analyzed twice for the Total Aluminum instead of for the OPO4. This lab error resulted in a data gap for that parameter on that date. Inspection of the graphical presentation of concentration results points out several anomalies that may represent sample contamination or other problems. Some are probably explained by simple typographical errors in the results reported by the laboratory. These cases will be investigated and conclusions presented in the next quarterly report after additional data are available. Another issue of concern is the apparent problems with the OPO4 and TP laboratory tests or sample handling protocol. Figure C6 shows greater dissolved P than total P in some cases. Sample handling procedures is not a likely explanation since the OPO4 should be conserved in most cases. Explaining these data and eliminating future occurrences will require further investigation to determine the source of this apparent error.

Deep Well Sampling

Table C1. Summary of OPO4 concentration results (µg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

WELL ID	March 19 2003	June 13 2003	June 27 2003	July 17 2003
A01	9787	10535	6679	12389
A02	4778	4974	4108	4972
A03	3090	2830	2470	2750
A04	1046	2129	1873	2138
A05	2587	2350	1965	2352
A06	3515	3735	2877	3091
A07	2081	2778	1716	2024
A08	2032	2115	1856	2362
A09	1061	1462	1412	1972
A10	3855	4020	3409	3888
A11	1550	1021	819	1558
A12	2312	2340	1821	1976
A13	1162	1966	1661	2506
A14	2067	1828	1349	1990
A15	2045	2783	799	2843
A16	2741	2605	1821	2696
A17	4637	4629	4223	4050
B01	448	666	508	792
B02	0	2	6	12
B03	0	0	6	10
B04	0	0	4	4
B05	0	0	6	6
B06	0	0	6	7
B07	146	124	77	239
B08	473	886	588	1396
B09	0	49	7	6
B10	0	0	21	15
B11	169	348	477	788
B12	1080	1273	1195	1230
B13	1164	980	1122	1900
B14	1680	1674	1795	4048
B15	760	810	906	1122
B16	1083	1741	1297	9869
B17	1624	1593	1725	1844
C01	18	0	6	6
C02	20	0	1144	7
C03	13	0	564	11
C04	18	0	693	13
C05	219	244	29	531
C06	60	109	368	63
C07	606	957	8	1235
C08	1034	1352	6	1780
C09	292	597	801	1103
C10	220	513	733	626
C11	26	16	28	26
C12	31	20	11	17
C13	14	0	34	5
C14	36	0	17	35
C15	18	0	12	15
C16	139	360	588	624
C17	479	663	682	1035

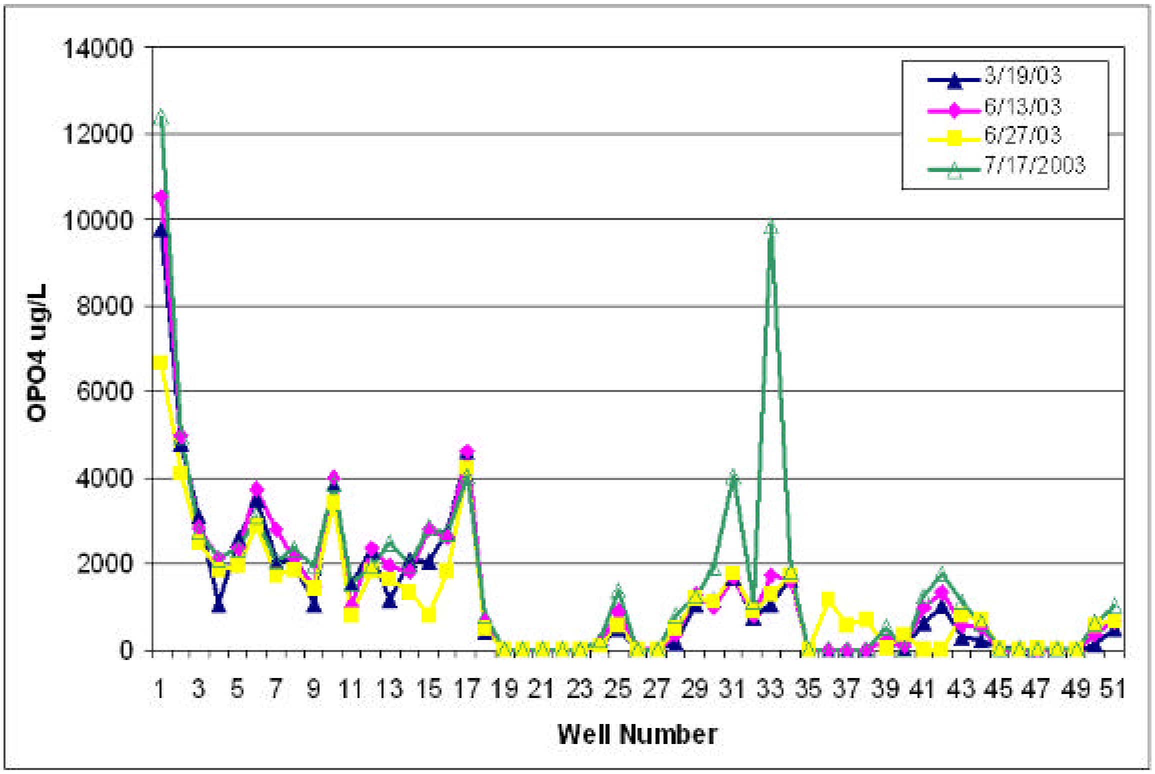

Figure C1. Summary of OPO4 concentration results (µg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

Table C2. Summary of TPDO4 concentration results (µg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

WELL ID	March 19 2003	June 13 2003	June 27 2003	July 17 2003
A01	4216	7074	11577	11037
A02	8037	5162	4622	4967
A03	2508	2474	2850	2751
A04	868	1773	2450	2326
A05	2112	1376	2171	2452
A06	2916	2490	3202	3179
A07	1372	2416	2094	2092
A08	1616	1253	2123	2351
A09	801	1519	1944	2024
A10	3196	2729	3914	3981
A11	1191	824	1294	1623
A12	1255	2547	2168	2309
A13	1016	2442	2502	2770
A14	1848	1058	2382	2602
A15	1673	2979	2390	2992
A16	1813	2978	2772	2740
A17	3637	3359	5141	5869
B01	115	609	642	780
B02	15	34	21	33
B03	5	27	18	81
B04	0	20	7	12
B05	0	18	17	29
B06	0	17	16	15
B07	104	215	233	393
B08	393	1294	971	1641
B09	0	22	24	13
B10	0	22	34	22
B11	45	442	722	998
B12	1019	1742	1495	1883
B13	1571	640	1631	1999
B14	648	1986	2796	6253
B15	1573	792	1125	1366
B16	809	1902	1775	10011
B17	1328	1911	1896	1979
C01	7	18	3	0
C02	0	23	8	15
C03	0	47	21	1347
C04	0	18	23	21
C05	203	397	491	182
C06	756	55	55	592
C07	14	1070	826	765
C08	1337	581	1611	476
C09	346	491	925	831
C10	240	390	776	431
C11	1	12	80	37
C12	2	46	37	24
C13	0	31	20	15
C14	7	20	41	35
C15	0	14	26	25
C16	106	503	763	611
C17	363	1026	835	696

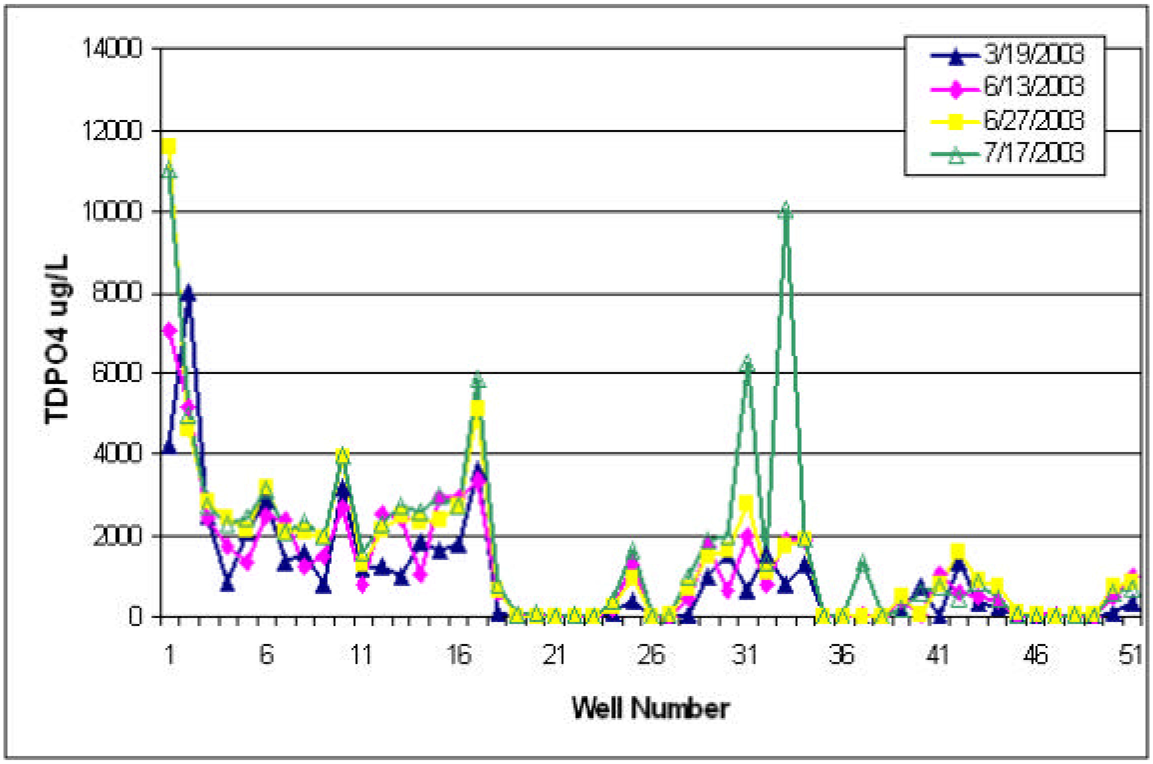

Figure C2. Summary of TDPO4 concentration results (µg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

Table C3. Summary of Total Aluminum concentration results (mg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

WELL ID	March 19 2003	June 13 2003	June 27 2003	July 17 2003
A01	4.7	0.5	2.5	1.9
A02	3.4	4.4	2.2	2.6
A03	4.5	3.2	3.0	3.0
A04	5.8	3.1	4.7	11.8
A05	7.1	0.7	2.6	3.3
A06	2.5	3.1	2.9	3.0
A07	2.6	1.1	2.6	2.4
A08	1.9	0.5	2.0	2.7
A09	2.0	0.7	3.0	2.7
A10	2.3	1.8	2.6	2.5
A11	2.1	0.7	1.9	2.5
A12	2.1	2.4	2.2	2.2
A13	1.5	1.4	2.2	2.3
A14	1.5	4.5	1.7	1.7
A15	1.5	1.2	2.3	2.0
A16	2.1	2.4	2.2	2.2
A17	1.8	1.0	1.6	1.6
B01	3.6	1.0	2.4	2.4
B02	0.4	0.8	2.9	2.8
B03	0.7	0.8	1.6	0.1
B04	0.7	0.8	1.2	1.1
B05	0.5	0.2	0.8	0.6
B06	0.6	0.2	0.9	0.7
B07	0.9	2.4	1.7	3.1
B08	0.3	1.0	5.3	0.7
B09	4.1	0.3	2.2	4.4
B10	0.4	0.3	1.1	0.7
B11	2.7	1.7	2.8	2.3
B12	2.9	1.6	2.2	1.9
B13	3.5	2.1	3.3	2.5
B14	2.7	1.3	4.0	2.5
B15	6.1	1.8	2.7	1.7
B16	2.7	0.4	2.3	2.1
B17	1.8	0.4	2.1	1.9
C01	0.6	0.4	0.8	0.1
C02	0.5	0.2	0.6	0.0
C03	0.5	0.2	1.0	0.1
C04	1.2	0.1	1.6	0.1
C05	1.0	0.3	1.9	1.8
C06	2.0	0.7	2.0	0.1
C07	2.0	1.5	1.5	0.4
C08	1.0	0.2	1.0	0.1
C09	0.5	0.1	0.7	0.1
C10	1.0	0.4	1.3	0.3
C11	1.5	0.7	8.0	2.2
C12	2.9	2.2	3.7	0.2
C13	4.2	0.4	0.8	3.5
C14	0.2	0.2	1.6	1.4
C15	0.9	0.7	3.0	1.3
C16	1.3	2.0	2.6	1.6
C17	3.7	0.7	2.3	1.4

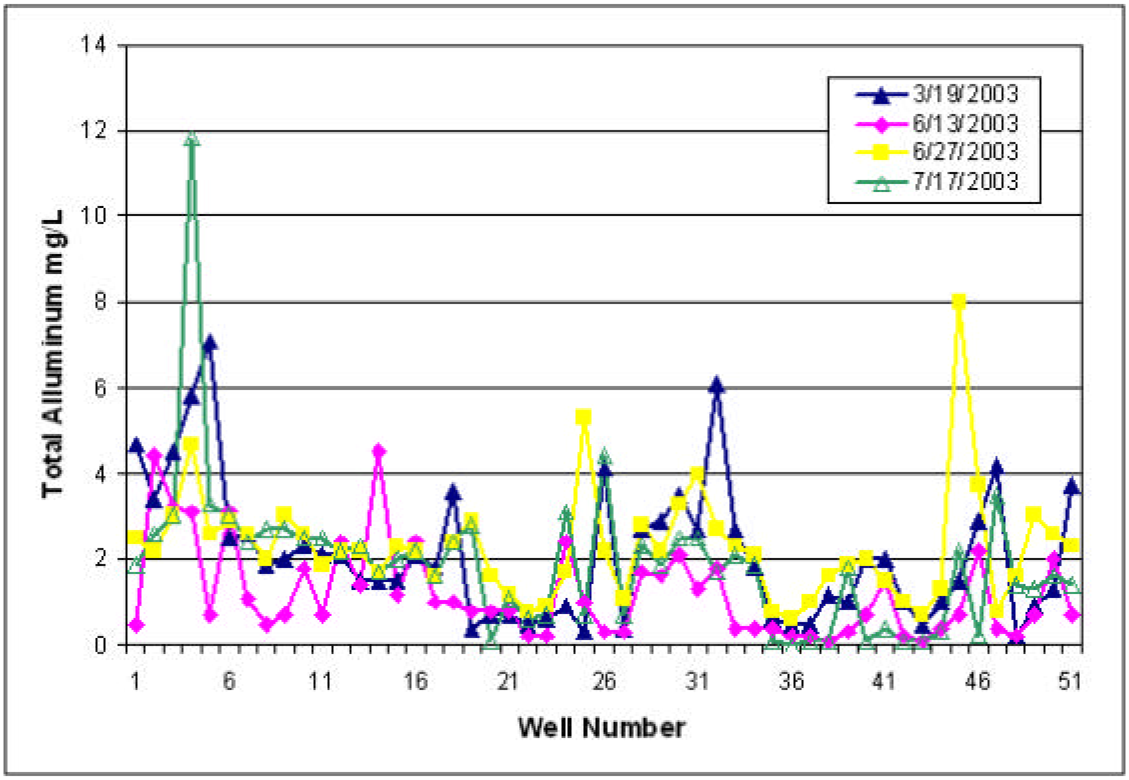

Figure C3. Summary of Total Aluminum concentration results (mg/L) in deep wells as sampled on March 19, June 13, June 27 and July 17, 2003.

Shallow Well Sampling

Table C4. Summary of TDPO4 concentration results (µg /L) in shallow wells as sampled on March 19 and June 24, 2003.

WELL ID	March 19 2003	June 24 2003
A01	2776	1130
A02	1747	440
A03	1521	1324
A04	939	693
A05	1147	418
A06	613	481
A07	932	211
A08	2073	8419
A09	2245	1143
A10	1985	1993
A11	355	138
A12	122	779
A13	2707	2060
A14	2359	1191
A15	672	5876
A16	2415	200
A17	1877	1265
B01	1574	745
B02	223	38
B03	1222	1174
B04	23	24
B05	1	14
B06	21	9
B07	354	742
B08	317	1074
B09	351	2353
B10	26	66
B11	373	995
B12	2262	2347
B13	371	1949
B14	2439	3469
B15	1239	23373
B16	1461	14984
B17	333	980
C01	21	38
C02	0	22
C03	9	130
C04	495	262
C05	505	80
C06	382	464
C07	1091	308
C08	2249	102
C09	228	146
C10	813	171
C11	1509	464
C12	19	44
C13	0	29
C14	411	221
C15	617	3144
C16	94	20
C17	201	42

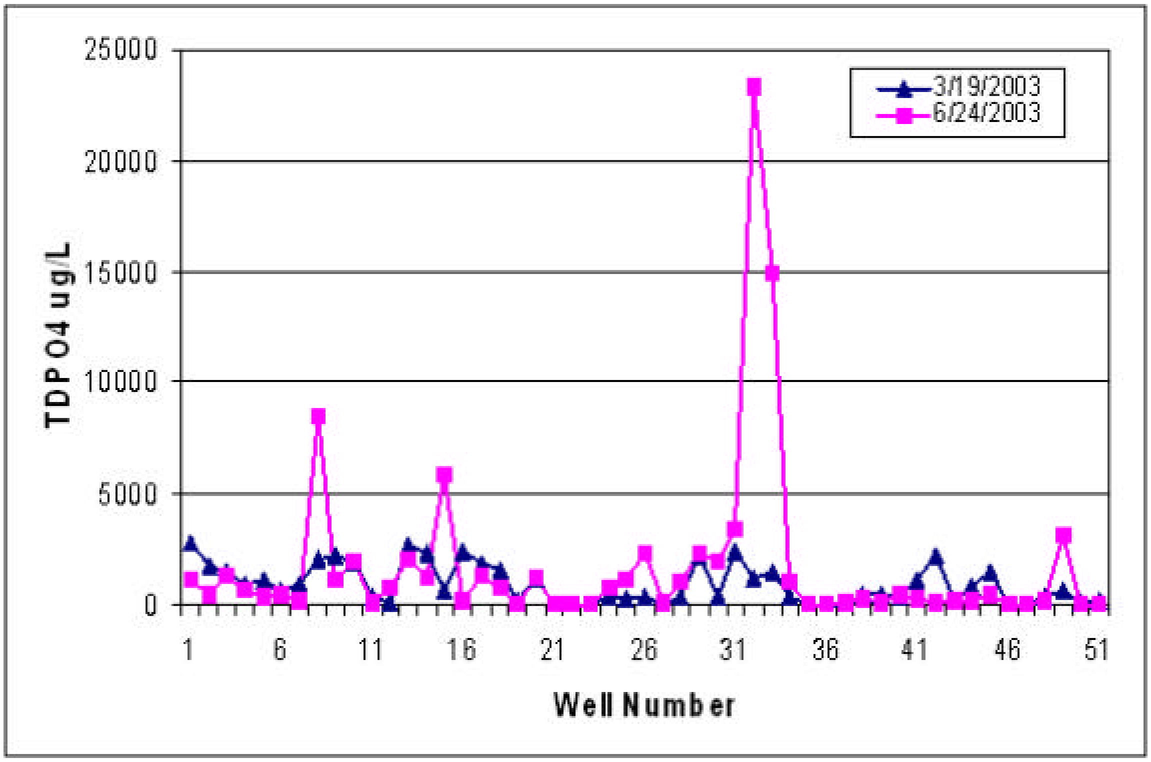

Figure C4. Summary of TDPO4 concentration results (µg /L) in shallow wells as sampled on March 19 and June 24, 2003.

Table C5. Summary of Total Aluminum concentration results (mg /L) in shallow wells as sampled on March 19 and June 24, 2003.

WELL ID	March 19 2003	June 24 2003
A01	0.9	0.7
A02	0.4	0.4
A03	0.8	0.8
A04	1.0	1.0
A05	1.0	0.3
A06	1.8	0.9
A07	1.3	0.3
A08	0.6	0.3
A09	1.1	0.8
A10	0.7	1.5
A11	1.0	1.0
A12	0.3	0.3
A13	0.4	0.3
A14	0.6	0.3
A15	0.8	0.2
A16	0.5	0.6
A17	1.0	1.2
B01	0.9	0.7
B02	1.7	1.2
B03	1.5	1.0
B04	2.8	2.8
B05	5.0	0.9
B06	4.6	2.0
B07	0.9	0.5
B08	0.7	0.6
B09	2.8	2.9
B10	1.7	5.9
B11	3.4	2.3
B12	0.8	0.6
B13	0.9	0.4
B14	0.9	0.4
B15	0.5	0.6
B16	0.9	0.7
B17	0.6	0.6
C01	1.0	0.9
C02	1.0	1.0
C03	0.4	0.6
C04	1.1	0.9
C05	0.9	1.7
C06	1.6	0.9
C07	0.8	0.9
C08	1.0	0.7
C09	0.3	0.3
C10	0.2	0.2
C11	1.5	1.1
C12	1.9	1.0
C13	0.9	1.1
C14	3.5	1.0
C15	1.5	1.1
C16	1.0	0.5
C17	1.4	1.0

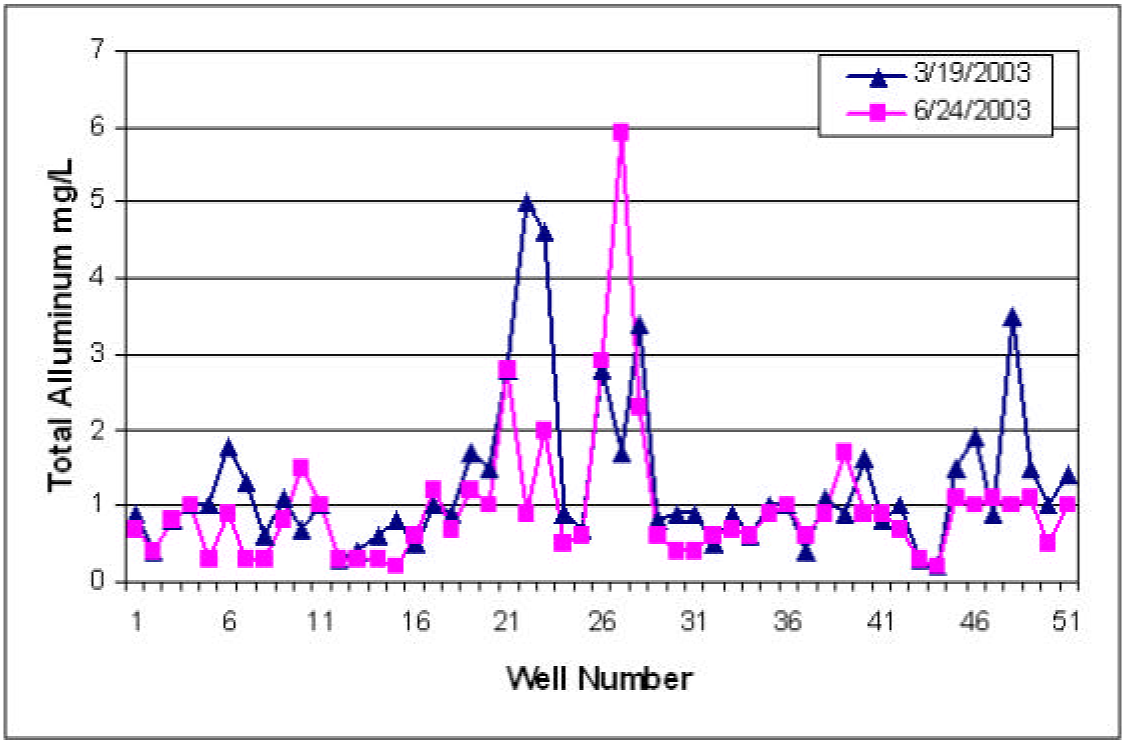

Figure C5. Summary of Total Aluminum concentration results (mg /L) in shallow wells as sampled on March 19 and June 24, 2003.

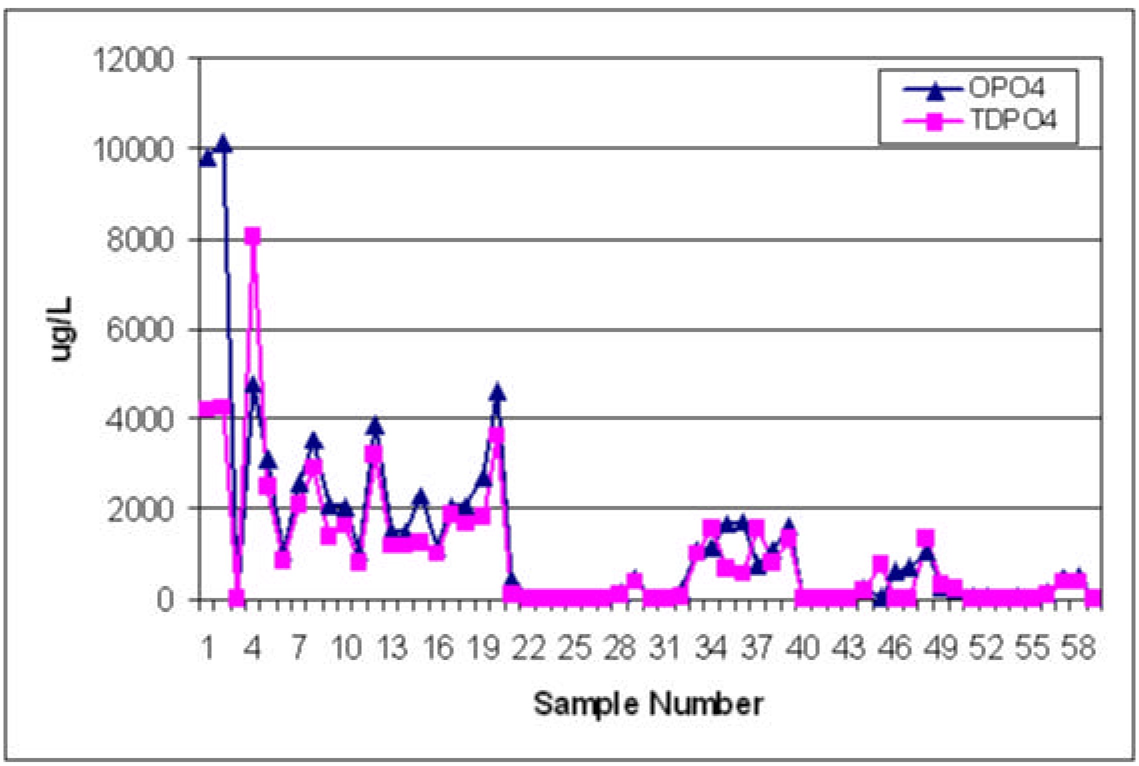

Figure C6. Comparison of TDPO4 and OPO4 concentration results (µg/L) in Kirton Ranch deep wells as sampled on March 19, 2003.

D. WEATHER

Rainfall response at the Kirton Ranch project site is documented in Figure D1 and shows a rising water table in response to approximately 12 inches of rainfall over the six-week period ending on July 31, 2003. The water table peaked at 0.7 feet below ground surface as measured at the A-09 flume location. Given a perimeter ditch depth of 10 inches, the critical depth to the water table reading is at approximately 0.7 feet. Any rise in the water table above the level will generate surface water runoff from the plots.

Each replicate block (A, B, and C) is equipped with a manual rain measurement cylinder as well as a tipping budget rain sensor. These extra sensors provide backup measurements of the project site conditions.

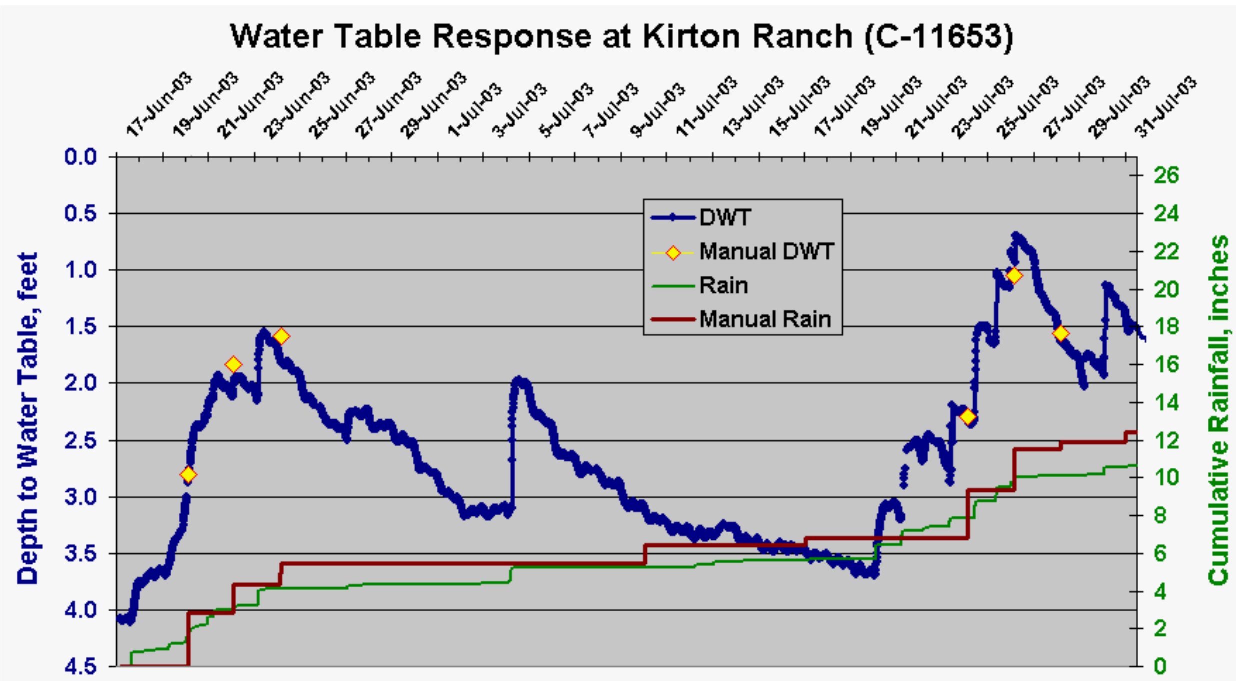

Figure D1. Summary of rainfall and water table response at Kirton Ranch.

E. SOIL & VEGETATION

Soil samples were taken from each plot on June 24-25, 2003. The surface (A horizon) sample was taken using a 2-cm diameter soil coring device. Approximately 15-20 cores, each 5 cm deep, were taken across the 0.5-acre plot and were composited. Since the application of WTR was not perfectly uniform, an effort was made to insert the coring tool where WTR was observed on the soil surface. E and Bh horizons were sampled from one hole drilled near the center of each plot using a 2-inch bucket auger. The E horizon was sampled approximately 5 cm below its interface with the A horizon. The Bh horizon was sampled just below its interface with the E horizon. The number of samples taken was 51 x 3 = 153 samples. They were air-dried and subdivided for analysis between Gainesville and Immokalee.

Vegetation samples were collected on July 10, 2003. A total of 57 samples were collected, one from each plot plus field duplicates at the first and last plot of each block. The vegetation was sampled by laying out a 1 meter by 1 meter frame. All grass within that framed area was cut using hand shears down to a height of 2 inches above the ground surface. The grass was raked together and placed into paper bags that were then folder, stapled and labeled. The samples were delivered to the IFAS research station in Immokalee where they were dried for subsequent analysis.

F. PROBLEMS & CORRECTIVE ACTIONS

Sampler Design and Fabrication

Originally, it was hoped that minor modifications to the paddlewheel samplers would make these units suitable for use on this small plot study. However, the designers were unable to provide a prototype for modification and testing. The performance of the units in a previous SFWMD study left open the question as to whether the reason for lack of water sample collection by these units was due to poor equipment performance or simply due to lack of runoff. The equipment problem was solved by designing and producing new sampling machines. These were to be low-cost, flow-integrating samplers. The previous units cost approximately $1000 per unit but did not include an accurate flow control flume. A Parshall flume design was incorporated into the sampler design. The new samplers were designed around a tiered flow-splitting approach using orifice control and float-controlled pumps. Eventually, a prototype unit was created and 55 units fabricated. Additional funds were requested in the initial project amendment to cover costs of the enhanced flumes and telemetry aspects of these new samplers, considered essential to proper performance of the system. But these funds were not approved. The problem was solved by incorporating these upgrades into the sampler design by using the lowest-cost engineering solutions available at the time of construction.

Ditch Construction

Originally, the plot perimeter ditches were designed to be much less abrupt and more similar to a swale. A gently sloping runoff collection swale around each plot was intended to allow these areas to be vegetated and mowed along with the rest of the plot. However, despite several attempts to construct ditches of this type, the available equipment could not produce a uniform swale and berm. Therefore a more traditional rotary ditch cutter was brought in to construct the ditches. The resulting 20-inch wide by 10-inch deep ditches have abrupt walls and therefore cannot be mowed. Maintenance of these ditches requires periodic herbicide treatment.

Tropical Soda Apple

The field has a tropical soda apple problem. This requires periodic cutting and removal of these and some other weeds. No budget was provided for this but the task is being addressed nevertheless.

Telemetry System

Project funding provided for telemetry to be connected only to 3 of the 51 samples. However, the desire for improved data quality motivated the other 48 samplers to be connected to an expanded telemetry system. This required the use of many more instruments (3 multiplexers, 2 additional dataloggers, 2 additional radio systems, 13,000 feet of cable, and 48 control sensors).

Ground Water Monitoring

The long distance to the project site (70 miles) and the infrequency of runoff events required that ground water levels be included in the telemetry system so the sampling team could anticipate the probability of a runoff event. To solve this problem three additional wells were installed along with a continuous ground water depth sensor at the central station of each 17-sample block.

Fertilizer Acquisition

Biosolids, chicken manure, alum residuals, and ammonium nitrate acquisition expenses were not provided in the project budget. The biosolids and other waste materials were to be included as part of the site selection criteria. The selected site was to already have these materials as part of the farm management program. The site selected by SFWMD did not meet these criteria and the burden of farm operations management fell to the contractor. Therefore funds to provide for this added procurement expenses were to be provided from the WERF project funds of an IFAS cooperator. These funds were not forthcoming. However, the prime IFAS contractor (Dr. Tom Obreza) did make additional funds available through another mechanism, by performing the water sample analyses at a reduced cost.

Agricultural Use Permits

Since the site selected for the project did not have an existing biosolids application program, permit applications had to be develop and submitted. A modification to the demonstration project design changed this requirement from one biosolids source to two sources, thus requiring a second permit application. DEP facilitated approval of both applications and the permits were granted.

Hay Harvesting

Hay harvesting has been the most intractable of all project problems. No budget for grass cutting or hay harvesting was provided in the initial budget. A condition of the project site selection criteria was that the ranch selected for the project would have an existing hay operation where the task of cutting and harvesting would be handled by the property owner. The site selected by the project sponsor did not meet these criteria and the burden of farm operations management fell to the contractor. The first solution attempted was to provide some limited funds ($5000 per year) in a project amendment to subsidize the rancher to harvest the hay ten times in two years. This proved to be an inadequate incentive. Next, four private hay harvesting companies were asked to submit bids for the job of hay harvesting. Three visited the site but none were willing to submit bids because of the small size of the plots (66 feet by 311 feet). The next attempt was to secure a machine designed to collect grass clippings from a cut golf course fairway. However, to test this machine required access to a 50+ HP tractor with hydraulic PTO ports. Short-term use of such a tractor was requested from both the rancher and the SFWMD. Neither provided this assistance. Cost effective solutions to this problem are still being sought.

Project Initiation

Upon completion of the basic site construction in June of 2002, the project was unable to start because (1) the grass had not been cut and (2) the materials has not been purchased and applied. Both of these limiting factors were originally conditions of the site selection process (an existing biosolids and hay operations site). The fertilizer materials could not be delivered and applied until the hay had been cut and harvested. To solve the problem it was recommended that the grass simply be cut and not harvested to allow the fertilizers to be applied and the project started. The project sponsor did not approve this recommendation in the summer of 2002 but did approve this request in the spring of 2003. This allowed the materials to be delivered and applied prior to the commencement of the 2003 rainy season. Solutions to the hay harvesting problem are still being pursued.

Onsite Facilities

The remote location of the ranch site and the lack of on-site storage and shelter required that some sort of shelter be provided to allow for both equipment storage and a field sample processing lab. A request for funds to provide a temporary building was included in the project amendment. But this request was not approved. The first attempt at a solution involved adapting a golf cart to serve as an edge-of-plot processing platform. However, the problem of rain interfering with sample processing plus the difficulties of keeping the gasoline-powered golf cart running made this solution impractical. The problem was solved when an old shed provided by the rancher for use by the project was renovated to include insulated walls, a door, insulated ceiling, and air conditioning unit. The shed now serves as equipment storage, sample processing lab, and crew shelter during thunderstorms.

Solar Panels

The solar panels purchased for the project experienced a high failure rate. The failed units (approximately 20) were identified and returned to the manufacturer for replacement. The new panels were installed and no additional failures of the remaining 31 original panels have been observed.

Batteries

Many of the batteries purchased for this project were failing to hold a proper charge. This occurred in part due to the extended duration of the project. The batteries have a limited life and the extension of the project pushed the battery limits. A major reason for the battery failures was the lack of cycling. The 51 batteries sit unused but charged at the site for most months of the year and then are used sporadically during the brief runoff events. During the first year (2002) that these units were in the field they were not called upon to deliver significant power because of the lack of runoff. Therefore, some artificial form of battery cycling must be added to the system or the batteries must be rotated out for cycling in the office workshop. This problem has been addressed in the short-term by purchasing 15 replacement batteries to cover the failed units. However, an automated power drain system will have to be designed and installed to properly cycle the batteries down to 10.5 volts once a month.

Sampling Equipment

The need to sample a large number of wells in a single day requires an efficient system for sampling the 103 wells. Purging the deeper wells requires removal of 5 gallons per well prior to taking a sample. The pump capacity and battery power capacity to deliver a rate of 3 GPM requires a fairly capable pump and large batteries. Driving through the field with a vehicle is not an efficient solution given the elongated plots and would damage the plots during the wet season. The problem was solved by building two hand carts to carry the pumps, batteries, and other sampling supplies, one purge pump cart and one sampling pump cart. The tall grass and 20-inch wide, 10-inch deep pair of ditches between each plot required that large-diameter wheels (bicycle size) be used to clear the ditches. However the impact loading caused by repeatedly falling into these small ditches caused the carts to bend and fail. The carts were reinforced with steel frame braces and this solved the problem. The large diameter wheels also helped the carts move easily through the tall grass. Several different purge pumps have been used to achieve the suction head and pumping rate requirements of the project. However most of the selected pumps have failed due to overheating, sand and mud abrasion, or insufficient pumping capacity. New purge pumps have been installed on the cart system.

G. ACTIVITIES PLANNED FOR NEXT QUARTER

Activities planned for the summer of 2003 will center around the basic monthly ground water sampling, supplemental ground water sampling during periods of heavy rain, surface water grab sample collection, surface water automatic sample collection, soil sample collection, vegetation sample collection, maintenance of the automatic water samples, cutting the grass, and harvesting the hay.

H. LIST OF APPENDICES

Appendix 1 – Ground Water Quality Results Summaries By Date

Appendix 2 - Ground Water Levels Measurements

Appendix 3 - Ground Water Physical Parameters Summary

Appendix 4 – Ground Water Parameter Contour Maps

Appendix 1
Ground Water Quality Results Summaries by Date

March 19, 2003 - Deep and Shallow Wells

Table 1. Laboratory analysis results for T-Al, OPO4 and TDPO4 concentrations in the ground water samples taken at Kirton Ranch (Row A) on March 19, 2003.

Row	Plot	QA/QC Code	Well Type	T-Al mg/L	Well Type	T-Al mg/L	Well Type	TDPO4 µg/L	Well Type	TDPO4 µg/L	Well Type	OPO4 µg/L
A	**1**	N	S	0.9	D	4.7	S	2776	D	4216	D	9787
A	**1**	FD	S	0.6	D	3.2	S	2387	D	4265	D	10142
A	**1**	EB	S	0.0	D	0.0	S	0	D	18	D	2
A	**2**	N	S	0.4	D	3.4	S	1747	D	8037	D	4778
A	**3**	N	S	0.8	D	4.5	S	1521	D	2508	D	3090
A	**4**	N	S	1.0	D	5.8	S	939	D	868	D	1046
A	**5**	N	S	1.0	D	7.1	S	1147	D	2112	D	2587
A	**6**	N	S	1.8	D	2.5	S	613	D	2916	D	3515
A	**7**	N	S	1.3	D	2.6	S	932	D	1372	D	2081
A	**8**	N	S	0.6	D	1.9	S	2073	D	1616	D	2032
A	**9**	N	S	1.1	D	2.0	S	2245	D	801	D	1061
A	**10**	N	S	0.7	D	2.3	S	1985	D	3196	D	3855
A	**11**	N	S	1.0	D	2.1	S	355	D	1191	D	1550
A	**11**	FD	S	0.9	D	1.8	S	275	D	1214	D	1497
A	**12**	N	S	0.3	D	2.1	S	122	D	1255	D	2312
A	**13**	N	S	0.4	D	1.5	S	2707	D	1016	D	1162
A	**14**	N	S	0.6	D	1.5	S	2359	D	1848	D	2067
A	**15**	N	S	0.8	D	1.5	S	672	D	1673	D	2045
A	**16**	N	S	0.5	D	2.1	S	2415	D	1813	D	2741
A	**17**	N	S	1.0	D	1.8	S	1877	D	3637	D	4637

N-Normal sample; EB- Equipment Blanks; FD- Field Duplicate; S-Shallow wells; D-Deep well

Table 2. Laboratory analysis results for T-Al, OPO4 and TDPO4 concentrations in the ground water samples taken at Kirton Ranch (Row B) on March 19, 2003.

Row	Plot	QA/QC Code	Well Type	T-Al mg/L	Well Type	T-Al mg/L	Well Type	TDPO4 µg/L	Well Type	TDPO4 µg/L	Well Type	OPO4 µg/L
B	**1**	N	S	0.9	D	3.6	S	1574	D	115	D	448
B	**2**	N	S	1.7	D	0.4	S	223	D	15	D	0
B	**3**	N	S	1.5	D	0.7	S	1222	D	5	D	0
B	**4**	N	S	2.8	D	0.7	S	23	D	0	D	0
B	**4**	FD	S	2.4	D	0.7	S	25	D	0	D	0
B	**5**	N	S	5.0	D	0.5	S	1	D	0	D	0
B	**6**	N	S	4.6	D	0.6	S	21	D	0	D	0
B	**7**	N	S	0.9	D	0.9	S	354	D	104	D	146
B	**8**	N	S	0.7	D	0.3	S	317	D	393	D	473
B	**9**	N	S	2.8	D	4.1	S	351	D	0	D	0
B	**10**	N	S	1.7	D	0.4	S	26	D	0	D	0
B	**11**	N	S	3.4	D	2.7	S	373	D	45	D	169
B	**12**	N	S	0.8	D	2.9	S	2262	D	1019	D	1080
B	**13**	N	S	0.9	D	3.5	S	371	D	1571	D	1164
B	**14**	N	S	0.9	D	2.7	S	2439	D	648	D	1680
B	**14**	FD	S	0.8	D	2.2	S	2336	D	563	D	1699
B	**15**	N	S	0.5	D	6.1	S	1239	D	1573	D	760
B	**16**	N	S	0.9	D	2.7	S	1461	D	809	D	1083
B	**17**	N	S	0.6	D	1.8	S	333	D	1328	D	1624

N-Normal sample; EB- Equipment Blanks; FD- Field Duplicate; S-Shallow wells; D-Deep well

Table 3. Laboratory analysis results for T-Al, OPO4 and TDPO4 concentrations in the ground water samples taken at Kirton Ranch (Row C) on March 19, 2003.

Row	Plot	QA/QC Code	Well Type	T-Al mg/L	Well Type	T-Al mg/L	Well Type	TDPO4 µg/L	Well Type	TDPO4 µg/L	Well Type	OPO4 µg/L
C	**1**	N	S	1.0	D	0.6	S	21	D	7	D	18
C	**2**	N	S	1.0	D	0.5	S	0	D	0	D	20
C	**3**	N	S	0.4	D	0.5	S	9	D	0	D	13
C	**4**	N	S	1.1	D	1.2	S	495	D	0	D	18
C	**5**	N	S	0.9	D	1.0	S	505	D	203	D	219
C	**6**	N	S	1.6	D	2.0	S	382	D	756	D	60
C	**7**	N	S	0.8	D	2.0	S	1091	D	14	D	606
C	**7**	FD	S	0.9	D	2.0	S	970	D	0	D	695
C	**8**	N	S	1.0	D	1.0	S	2249	D	1337	D	1034
C	**9**	N	S	0.3	D	0.5	S	228	D	346	D	292
C	**10**	N	S	0.2	D	1.0	S	813	D	240	D	220
C	**11**	N	S	1.5	D	1.5	S	1509	D	1	D	26
C	**12**	N	S	1.9	D	2.9	S	19	D	2	D	31
C	**13**	N	S	0.9	D	4.2	S	0	D	0	D	14
C	**14**	N	S	3.5	D	0.2	S	411	D	7	D	36
C	**15**	N	S	1.5	D	0.9	S	617	D	0	D	18
C	**16**	N	S	1.0	D	1.3	S	94	D	106	D	139
C	**17**	N	S	1.4	D	3.7	S	201	D	363	D	479
C	**17**	FD	S	1.3	D	3.2	S	188	D	392	D	521
C	**17**	EB	S	0.0	D	0.0	S	0	D	0	D	18

N-Normal sample; EB- Equipment Blanks; FD- Field Duplicate; S-Shallow wells; D-Deep well

Comment: The lab incorrectly performed the aluminum test on the orthophosphate samples; therefore, orthophosphates concentrations in the shallow wells are not available for this sampling date.

June 13, 2003 - Deep Wells

Table 4. OPO4concentration (µg/L) in deep wells as sampled on June 13, 2003.

Row	Plot	QA/QC Code	OPO4 µg/L	Row	Plot	QA/QC Code	OPO4 µg/L	Row	Plot	QA/QC Code	OPO4 µg/L
A	**1**	N	10535	**B**	**1**	N	666	**C**	**1**	N	0
A	**1**	FD	10695	**B**	**2**	N	2	**C**	**2**	N	0
A	**1**	EB	50	**B**	**3**	N	0	**C**	**3**	N	0
A	**2**	N	4974	**B**	**4**	N	0	**C**	**4**	N	0
A	**3**	N	2830	**B**	**4**	FD	0	**C**	**5**	N	244
A	**4**	N	2129	**B**	**5**	N	0	**C**	**6**	N	109
A	**5**	N	2350	**B**	**6**	N	0	**C**	**7**	N	957
A	**6**	N	3735	**B**	**7**	N	124	**C**	**7**	FD	726
A	**7**	N	2778	**B**	**8**	N	886	**C**	**8**	N	1352
A	**8**	N	2115	**B**	**9**	N	49	**C**	**9**	N	597
A	**9**	N	1462	**B**	**10**	N	0	**C**	**10**	N	513
A	**10**	N	4020	**B**	**11**	N	348	**C**	**11**	N	16
A	**11**	N	1021	**B**	**12**	N	1273	**C**	**12**	N	20
A	**11**	FD	1198	**B**	**13**	N	980	**C**	**13**	N	0
A	**12**	N	2340	**B**	**14**	N	1674	**C**	**14**	N	0
A	**13**	N	1966	**B**	**14**	FD	1694	**C**	**15**	N	0
A	**14**	N	1828	**B**	**15**	N	810	**C**	**16**	N	360
A	**15**	N	2783	**B**	**16**	N	1741	**C**	**17**	N	663
A	**16**	N	2605	**B**	**17**	N	1593	**C**	**17**	FD	517
A	**17**	N	4629	**B**	**17**	LB	42	**C**	**17**	EB	1

Table 5. TDPO4 concentration (µg/L) in deep wells as sampled on June 13, 2003.

Row	Plot	QA/QC	TDPO4	Row	Plot	QA/QC	TDPO4	Row	Plot	QA/QC	TDPO4
		Code	µg/L			Code	µg/L			Code	µg/L
A	**1**	N	7074	**B**	**1**	N	609	**C**	**1**	N	18
A	**1**	FD	4293	**B**	**2**	N	34	**C**	**2**	N	23
A	**1**	EB	29	**B**	**3**	N	27	**C**	**3**	N	47
A	**2**	N	5162	**B**	**4**	N	20	**C**	**4**	N	18
A	**3**	N	2474	**B**	**4**	FD	17	**C**	**5**	N	397
A	**4**	N	1773	**B**	**5**	N	18	**C**	**6**	N	55
A	**5**	N	1376	**B**	**6**	N	17	**C**	**7**	N	1070
A	**6**	N	2490	**B**	**7**	N	215	**C**	**7**	FD	1085
A	**7**	N	2416	**B**	**8**	N	1294	**C**	**8**	N	581
A	**8**	N	1253	**B**	**9**	N	22	**C**	**9**	N	491
A	**9**	N	1519	**B**	**10**	N	22	**C**	**10**	N	390
A	**10**	N	2729	**B**	**11**	N	442	**C**	**11**	N	12
A	**11**	N	824	**B**	**12**	N	1742	**C**	**12**	N	46
A	**11**	FD	620	**B**	**13**	N	640	**C**	**13**	N	31
A	**12**	N	2547	**B**	**14**	N	1986	**C**	**14**	N	20
A	**13**	N	2442	**B**	**14**	FD	1572	**C**	**15**	N	14
A	**14**	N	1058	**B**	**15**	N	792	**C**	**16**	N	503
A	**15**	N	2979	**B**	**16**	N	1902	**C**	**17**	N	1026
A	**16**	N	2978	**B**	**17**	N	1911	**C**	**17**	FD	892
A	**17**	N	3359	**B**	**17**	LB	50	**C**	**17**	EB	22

Table 6. Total –Al concentration (mg/L) in deep wells as sampled on June 13, 2003.

Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al mg/L
A	**1**	N	0.5	**B**	**1**	N	1.0	**C**	**1**	N	0.4
A	**1**	FD	1.7	**B**	**2**	N	0.8	**C**	**2**	N	0.2
A	**1**	EB	0.0	**B**	**3**	N	0.8	**C**	**3**	N	0.2
A	**2**	N	4.4	**B**	**4**	N	0.8	**C**	**4**	N	0.1
A	**3**	N	3.2	**B**	**4**	FD	0.6	**C**	**5**	N	0.3
A	**4**	N	3.1	**B**	**5**	N	0.2	**C**	**6**	N	0.7
A	**5**	N	0.7	**B**	**6**	N	0.2	**C**	**7**	N	1.5
A	**6**	N	3.1	**B**	**7**	N	2.4	**C**	**7**	FD	0.5
A	**7**	N	1.1	**B**	**8**	N	1.0	**C**	**8**	N	0.2
A	**8**	N	0.5	**B**	**9**	N	0.3	**C**	**9**	N	0.1
A	**9**	N	0.7	**B**	**10**	N	0.3	**C**	**10**	N	0.4
A	**10**	N	1.8	**B**	**11**	N	1.7	**C**	**11**	N	0.7
A	**11**	N	0.7	**B**	**12**	N	1.6	**C**	**12**	N	2.2
A	**11**	FD	0.9	**B**	**13**	N	2.1	**C**	**13**	N	0.4
A	**12**	N	2.4	**B**	**14**	N	1.3	**C**	**14**	N	0.2
A	**13**	N	1.4	**B**	**14**	FD	1.2	**C**	**15**	N	0.7
A	**14**	N	4.5	**B**	**15**	N	1.8	**C**	**16**	N	2.0
A	**15**	N	1.2	**B**	**16**	N	0.4	**C**	**17**	N	0.7
A	**16**	N	2.4	**B**	**17**	N	0.4	**C**	**17**	FD	1.3
A	**17**	N	1.0	**B**	**17**	LB	0.0	**C**	**17**	EB	0.0

June 24, 2003 - Shallow Wells

Table 7. TDPO4 concentration (µg/L) in shallow wells as sampled on June 24, 2003.

Row	Plot	QA/QC Code	TDPO4 µg/L	Row	Plot	QA/QC Code	TDPO4 µg/L	Row	Plot	QA/QC Code	TDPO4 µg/L
A	**1**	N	3495	**B**	**1**	N	1647	**C**	**1**	N	23
A	**1**	FD	3300	**B**	**2**	N	78	**C**	**2**	N	14
A	**1**	EB	5	**B**	**3**	N	1165	**C**	**3**	N	332
A	**2**	N	1339	**B**	**4**	N	11	**C**	**4**	N	544
A	**3**	N	2037	**B**	**4**	FD	9	**C**	**5**	N	238
A	**4**	N	1391	**B**	**5**	N	26	**C**	**6**	N	1166
A	**5**	N	861	**B**	**6**	N	13	**C**	**7**	N	959
A	**6**	N	628	**B**	**7**	N	710	**C**	**7**	FD	985
A	**7**	N	190	**B**	**8**	N	1210	**C**	**8**	N	279
A	**8**	N	9485	**B**	**9**	N	2576	**C**	**9**	N	312
A	**9**	N	1615	**B**	**10**	N	21	**C**	**10**	N	329
A	**10**	N	654	**B**	**11**	N	877	**C**	**11**	N	836
A	**11**	N	2498	**B**	**12**	N	2487	**C**	**12**	N	24
A	**11**	FD	2147	**B**	**13**	N	2047	**C**	**13**	N	30
A	**12**	N	119	**B**	**14**	N	3957	**C**	**14**	N	480
A	**13**	N	2323	**B**	**14**	FD	3354	**C**	**15**	N	3810
A	**14**	N	1856	**B**	**15**	N	24995	**C**	**16**	N	95
A	**15**	N	6362	**B**	**16**	N	23012	**C**	**17**	N	77
A	**16**	N	541	**B**	**17**	N	1089	**C**	**17**	FD	77
A	**17**	N	2446	**B**	**17**	LB	10	**C**	**17**	EB	8

Table 8. Total-Al concentration (mg/L) in shallow wells as sampled on June 24, 2003.

Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al mg/L
A	**1**	N	0.7	**B**	**1**	N	0.7	**C**	**1**	N	0.9
A	**1**	FD	1.0	**B**	**2**	N	1.2	**C**	**2**	N	1.0
A	**1**	EB	0.0	**B**	**3**	N	1.0	**C**	**3**	N	0.6
A	**2**	N	0.4	**B**	**4**	N	2.8	**C**	**4**	N	0.9
A	**3**	N	0.8	**B**	**4**	FD	3.5	**C**	**5**	N	1.7
A	**4**	N	1.0	**B**	**5**	N	0.9	**C**	**6**	N	0.9
A	**5**	N	0.3	**B**	**6**	N	2.0	**C**	**7**	N	0.9
A	**6**	N	0.9	**B**	**7**	N	0.5	**C**	**7**	FD	0.8
A	**7**	N	0.3	**B**	**8**	N	0.6	**C**	**8**	N	0.7
A	**8**	N	0.3	**B**	**9**	N	2.9	**C**	**9**	N	0.3
A	**9**	N	0.8	**B**	**10**	N	5.9	**C**	**10**	N	0.2
A	**10**	N	1.5	**B**	**11**	N	2.3	**C**	**11**	N	1.1
A	**11**	N	1.0	**B**	**12**	N	0.6	**C**	**12**	N	1.0
A	**11**	FD	0.9	**B**	**13**	N	0.4	**C**	**13**	N	1.1
A	**12**	N	0.3	**B**	**14**	N	0.4	**C**	**14**	N	1.0
A	**13**	N	0.3	**B**	**14**	FD	0.5	**C**	**15**	N	1.1
A	**14**	N	0.3	**B**	**15**	N	0.6	**C**	**16**	N	0.5
A	**15**	N	0.2	**B**	**16**	N	0.7	**C**	**17**	N	1.0
A	**16**	N	0.6	**B**	**17**	N	0.6	**C**	**17**	FD	1.0
A	**17**	N	1.2	**B**	**17**	LB	0.1	**C**	**17**	EB	0.1

June 27, 2003 - Deep Wells

Table 9. OPO4 concentration (µg/L) in deep wells as sampled on June 27, 2003.

Row	Plot	QA/QC	OPO4	Row	Plot	QA/QC	OPO4	Row	Plot	QA/QC	OPO4
		Code	µg/L			Code	µg/L			Code	µg/L
A	**1**	N	6679	**B**	**1**	N	508	**C**	**1**	N	6
A	**1**	FD	11616	**B**	**2**	N	6	**C**	**2**	N	1144
A	**1**	EB	3	**B**	**3**	N	6	**C**	**3**	N	564
A	**2**	N	4108	**B**	**4**	N	4	**C**	**4**	N	693
A	**3**	N	2470	**B**	**4**	FD	6	**C**	**5**	N	29
A	**4**	N	1873	**B**	**5**	N	6	**C**	**6**	N	368
A	**5**	N	1965	**B**	**6**	N	6	**C**	**7**	N	8
A	**6**	N	2877	**B**	**7**	N	77	**C**	**7**	FD	10
A	**7**	N	1716	**B**	**8**	N	588	**C**	**8**	N	6
A	**8**	N	1856	**B**	**9**	N	7	**C**	**9**	N	801
A	**9**	N	1412	**B**	**10**	N	21	**C**	**10**	N	733
A	**10**	N	3409	**B**	**11**	N	477	**C**	**11**	N	28
A	**11**	N	819	**B**	**12**	N	1195	**C**	**12**	N	11
A	**11**	FD	1066	**B**	**13**	N	1122	**C**	**13**	N	34
A	**12**	N	1821	**B**	**14**	N	1795	**C**	**14**	N	17
A	**13**	N	1661	**B**	**14**	FD	1860	**C**	**15**	N	12
A	**14**	N	1349	**B**	**15**	N	906	**C**	**16**	N	588
A	**15**	N	799	**B**	**16**	N	1297	**C**	**17**	N	682
A	**16**	N	1821	**B**	**17**	N	1725	**C**	**17**	FD	899
A	**17**	N	4223	**B**	**17**	LB	3	**C**	**17**	EB	7

Table 10. TDPO4 concentration (µg/L) in deep wells as sampled on June 27, 2003.

Row	Plot	QA/QC Code	TDPO4 µg/L	Row	Plot	QA/QC Code	TDPO4 µg/L	Row	Plot	QA/QC Code	TDPO4 µg/L
A	**1**	N	11577	**B**	**1**	N	642	**C**	**1**	N	3
A	**1**	FD	11595	**B**	**2**	N	21	**C**	**2**	N	8
A	**1**	EB	5	**B**	**3**	N	18	**C**	**3**	N	21
A	**2**	N	4622	**B**	**4**	N	7	**C**	**4**	N	23
A	**3**	N	2850	**B**	**4**	FD	5	**C**	**5**	N	491
A	**4**	N	2450	**B**	**5**	N	17	**C**	**6**	N	55
A	**5**	N	2171	**B**	**6**	N	16	**C**	**7**	N	826
A	**6**	N	3202	**B**	**7**	N	233	**C**	**7**	FD	835
A	**7**	N	2094	**B**	**8**	N	971	**C**	**8**	N	1611
A	**8**	N	2123	**B**	**9**	N	24	**C**	**9**	N	925
A	**9**	N	1944	**B**	**10**	N	34	**C**	**10**	N	776
A	**10**	N	3914	**B**	**11**	N	722	**C**	**11**	N	80
A	**11**	N	1294	**B**	**12**	N	1495	**C**	**12**	N	37
A	**11**	FD	1395	**B**	**13**	N	1631	**C**	**13**	N	20
A	**12**	N	2168	**B**	**14**	N	2796	**C**	**14**	N	41
A	**13**	N	2502	**B**	**14**	FD	2508	**C**	**15**	N	26
A	**14**	N	2382	**B**	**15**	N	1125	**C**	**16**	N	763
A	**15**	N	2390	**B**	**16**	N	1775	**C**	**17**	N	835
A	**16**	N	2772	**B**	**17**	N	1896	**C**	**17**	FD	850
A	**17**	N	5141	**B**	**17**	LB	0	**C**	**17**	EB	11

Table 11. Total Al concentration (mg/L) in deep wells as sampled on June 27, 2003.

Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al mg/L	Row	Plot	QA/QC Code	T-Al Mg/L
A	**1**	N	2.5	**B**	**1**	N	2.4	**C**	**1**	N	0.8
A	**1**	FD	2.6	**B**	**2**	N	2.9	**C**	**2**	N	0.6
A	**1**	EB	0.2	**B**	**3**	N	1.6	**C**	**3**	N	1.0
A	**2**	N	2.2	**B**	**4**	N	1.2	**C**	**4**	N	1.6
A	**3**	N	3.0	**B**	**4**	FD	1.0	**C**	**5**	N	1.9
A	**4**	N	4.7	**B**	**5**	N	0.8	**C**	**6**	N	2.0
A	**5**	N	2.6	**B**	**6**	N	0.9	**C**	**7**	N	1.5
A	**6**	N	2.9	**B**	**7**	N	1.7	**C**	**7**	FD	1.3
A	**7**	N	2.6	**B**	**8**	N	5.3	**C**	**8**	N	1.0
A	**8**	N	2.0	**B**	**9**	N	2.2	**C**	**9**	N	0.7
A	**9**	N	3.0	**B**	**10**	N	1.1	**C**	**10**	N	1.3
A	**10**	N	2.6	**B**	**11**	N	2.8	**C**	**11**	N	8.0
A	**11**	N	1.9	**B**	**12**	N	2.2	**C**	**12**	N	3.7
A	**11**	FD	2.0	**B**	**13**	N	3.3	**C**	**13**	N	0.8
A	**12**	N	2.2	**B**	**14**	N	4.0	**C**	**14**	N	1.6
A	**13**	N	2.2	**B**	**14**	FD	4.0	**C**	**15**	N	3.0
A	**14**	N	1.7	**B**	**15**	N	2.7	**C**	**16**	N	2.6
A	**15**	N	2.3	**B**	**16**	N	2.3	**C**	**17**	N	2.3
A	**16**	N	2.2	**B**	**17**	N	2.1	**C**	**17**	FD	2.4
A	**17**	N	1.6	**B**	**17**	LB	0.1	**C**	**17**	EB	0.1

July 17, 2003 - Deep Wells

Table 12. OPO4 concentration (µg/L) in deep wells as sampled on July 17, 2003.

Row	Plot	QA/QC Code	OPO4 µg/L	Row	Plot	QA/QC Code	OPO4 µg/L	Row	Plot	QA/QC Code	OPO4 µg/L
A	**1**	N	12389	**B**	**1**	N	792	**C**	**1**	N	6
A	**1**	FD	11680	**B**	**2**	N	12	**C**	**2**	N	7
A	**1**	EB	7	**B**	**3**	N	10	**C**	**3**	N	11
A	**2**	N	4972	**B**	**4**	N	4	**C**	**4**	N	13
A	**3**	N	2750	**B**	**4**	FD	5	**C**	**5**	N	531
A	**4**	N	2138	**B**	**5**	N	6	**C**	**6**	N	63
A	**5**	N	2352	**B**	**6**	N	7	**C**	**7**	N	1235
A	**6**	N	3091	**B**	**7**	N	239	**C**	**7**	FD	1051
A	**7**	N	2024	**B**	**8**	N	1396	**C**	**8**	N	1780
A	**8**	N	2362	**B**	**9**	N	6	**C**	**9**	N	1103
A	**9**	N	1972	**B**	**10**	N	15	**C**	**10**	N	626
A	**10**	N	3888	**B**	**11**	N	788	**C**	**11**	N	26
A	**11**	N	1558	**B**	**12**	N	1230	**C**	**12**	N	17
A	**11**	FD	1461	**B**	**13**	N	1900	**C**	**13**	N	5
A	**12**	N	1976	**B**	**14**	N	4048	**C**	**14**	N	35
A	**13**	N	2506	**B**	**14**	FD	5051	**C**	**15**	N	15
A	**14**	N	1990	**B**	**15**	N	1122	**C**	**16**	N	624
A	**15**	N	2843	**B**	**16**	N	9869	**C**	**17**	N	1035
A	**16**	N	2696	**B**	**17**	N	1844	**C**	**17**	FD	997
A	**17**	N	4050	**B**	**17**	LB	3	**C**	**17**	EB	18

Table 13. TDPO4 concentration (µg/L) in deep wells as sampled on July 17, 2003.

Row	Plot	QA/QC	TDPO4	Row	Plot	QA/QC	TDPO4	Row	Plot	QA/QC	TDPO4
		Code	µg/L			Code	µg/L			Code	µg/L
A	**1**	N	11037	**B**	**1**	N	780	**C**	**1**	N	7
A	**1**	FD	14031	**B**	**2**	N	33	**C**	**2**	N	15
A	**1**	EB	9	**B**	**3**	N	81	**C**	**3**	N	1347
A	**2**	N	4967	**B**	**4**	N	12	**C**	**4**	N	21
A	**3**	N	2751	**B**	**4**	FD	8	**C**	**5**	N	21
A	**4**	N	2326	**B**	**5**	N	29	**C**	**6**	N	80
A	**5**	N	2452	**B**	**6**	N	15	**C**	**7**	N	779
A	**6**	N	3179	**B**	**7**	N	393	**C**	**7**	FD	1348
A	**7**	N	2092	**B**	**8**	N	1641	**C**	**8**	N	1813
A	**8**	N	2351	**B**	**9**	N	13	**C**	**9**	N	1177
A	**9**	N	2024	**B**	**10**	N	22	**C**	**10**	N	671
A	**10**	N	3981	**B**	**11**	N	998	**C**	**11**	N	38
A	**11**	N	1623	**B**	**12**	N	1883	**C**	**12**	N	26
A	**11**	FD	1617	**B**	**13**	N	1999	**C**	**13**	N	15
A	**12**	N	2309	**B**	**14**	N	6253	**C**	**14**	N	42
A	**13**	N	2770	**B**	**14**	FD	6197	**C**	**15**	N	25
A	**14**	N	2602	**B**	**15**	N	1366	**C**	**16**	N	717
A	**15**	N	2992	**B**	**16**	N	10011	**C**	**17**	N	1059
A	**16**	N	2740	**B**	**17**	N	1979	**C**	**17**	FD	1021
A	**17**	N	5869	**B**	**17**	LB	5	**C**	**17**	EB	8

Table 14. Total Aluminum concentrations (mg/L) in deep wells as sampled on July 17, 2003.

Row	Plot	QA/QC Code	T-Al µg/L	Row	Plot	QA/QC Code	T-Al µg/L	Row	Plot	QA/QC Code	T-Al µg/L
A	**1**	N	1.9	**B**	**1**	N	2.4	**C**	**1**	N	0.7
A	**1**	FD	2.3	**B**	**2**	N	2.8	**C**	**2**	N	0.5
A	**1**	EB	0.1	**B**	**3**	N	0.1	**C**	**3**	N	0.6
A	**2**	N	2.6	**B**	**4**	N	1.1	**C**	**4**	N	1.3
A	**3**	N	3.0	**B**	**4**	FD	1.4	**C**	**5**	N	2.8
A	**4**	N	11.8	**B**	**5**	N	0.6	**C**	**6**	N	2.1
A	**5**	N	3.3	**B**	**6**	N	0.7	**C**	**7**	N	1.6
A	**6**	N	3.0	**B**	**7**	N	3.1	**C**	**7**	FD	1.6
A	**7**	N	2.4	**B**	**8**	N	0.7	**C**	**8**	N	0.9
A	**8**	N	2.7	**B**	**9**	N	4.4	**C**	**9**	N	0.6
A	**9**	N	2.7	**B**	**10**	N	0.7	**C**	**10**	N	1.3
A	**10**	N	2.5	**B**	**11**	N	2.3	**C**	**11**	N	3.7
A	**11**	N	2.5	**B**	**12**	N	1.9	**C**	**12**	N	3.1
A	**11**	FD	2.2	**B**	**13**	N	2.5	**C**	**13**	N	0.7
A	**12**	N	2.2	**B**	**14**	N	2.5	**C**	**14**	N	1.6
A	**13**	N	2.3	**B**	**14**	FD	2.4	**C**	**15**	N	2.2
A	**14**	N	1.7	**B**	**15**	N	1.7	**C**	**16**	N	2.9
A	**15**	N	2.0	**B**	**16**	N	2.1	**C**	**17**	N	2.3
A	**16**	N	2.2	**B**	**17**	N	1.9	**C**	**17**	FD	2.1
A	**17**	N	1.6	**B**	**17**	LB	0.0	**C**	**17**	EB	0.1

Appendix 2
Ground Water Levels Measurements

Ground water levels were recorded after collecting water samples from each well. The water surface was allowed time to recover to its original level prior to measurement of the depth. These readings were made relative to the top of the well manhole cover.

March 19, 2003 - Deep and Shallow Wells

Table 15. Ground water levels (DWT in feet) measured in Kirton Ranch deep and shallow wells on March 19, 2003.

PLOT	ROW A		ROW B		ROW C	
	DWT. (ft) shallow (3-ft)	DWT. (ft) deep (10-ft)	DWT. (ft) shallow (3-ft)	DWT. (ft) deep (10-ft)	DWT. (ft) shallow (3-ft)	DWT. (ft) deep (10-ft)
1	1.75	1.67	1.63	1.90	1.58	1.67
2	1.75	1.67	1.67	2.17	1.50	1.33
3	1.79	2.88	1.75	1.63	1.63	1.58
4	1.71	2.88	1.71	1.71	1.63	1.75
5	1.79	2.88	1.63	1.83	1.67	1.83
6	1.88	2.00	1.79	2.08	1.96	1.75
7	1.83	2.00	2.00	1.83	1.71	2.31
8	1.75	2.00	1.88	2.79	1.63	2.58
9	1.75	1.83	1.83	1.78	1.83	1.92
10	1.83	2.38	2.17	1.96	1.83	1.92
11	1.83	1.79	1.83	2.25	1.65	1.75
12	1.63	1.71	2.10	2.04	1.75	1.92
13	1.67	1.71	2.02	2.33	1.75	2.00
14	1.92	1.67	2.21	1.88	1.83	1.75
15	1.75	2.04	2.23	2.01	1.59	1.71
16	1.83	1.96	2.24	2.56	1.92	1.71
17	1.73	1.67	1.63	2.08	1.88	1.83

June 13, 2003 - Deep Wells

Table 16. Ground water levels (DWT in feet) measured in Kirton Ranch deep wells on June 13, 2003.

Plot	Row A DWT(10-ft)	Row B DWT(10-ft)	Row C DWT(10-ft)
1	2.98	1.90	2.75
2	3.00	2.17	2.44
3	3.19	1.63	2.50
4	3.10	1.71	2.63
5	3.17	1.83	2.75
6	3.23	2.08	2.75
7	3.15	1.83	2.81
8	3.00	2.79	3.04
9	3.02	1.78	3.02
10	2.81	1.96	2.81
11	3.02	2.25	3.02
12	3.17	2.04	3.00
13	3.00	2.33	3.02
14	3.08	1.88	2.75
15	3.27	2.01	3.10
16	3.02	2.56	3.02
17	2.79	2.08	3.13

June 24, 2003 - Shallow Wells

Table 17. Ground water levels (DWT in feet) measured in Kirton Ranch shallow wells on June 24, 2003.

Plot	Row A DWT(3-ft)	Row B DWT(3-ft)	Row C DWT(3-ft)
1	1.42	1.08	0.83
2	1.46	1.04	0.67
3	1.54	1.08	0.67
4	1.46	0.75	0.92
5	1.58	0.75	1.08
6	1.58	1.00	1.25
7	1.58	1.29	1.17
8	1.46	1.38	1.21
9	1.38	1.38	1.38
10	1.46	1.29	1.25
11	1.54	1.63	1.17
12	1.25	1.63	1.25
13	1.46	1.79	1.08
14	1.42	1.75	1.08
15	1.42	1.79	0.92
16	1.46	1.71	1.17
17	1.25	1.75	1.17

June 27, 2003 - Deep Wells

Table 18. Ground water levels (DWT in feet) measured in Kirton Ranch deep wells on June 27, 2003.

Plot	Row A DWT(10-ft)	Row B DWT(10-ft)	Row C DWT(10-ft)
1	2.31	1.25	0.83
2	2.08	1.25	0.67
3	2.42	1.13	0.63
4	2.13	1.08	0.92
5	2.13	1.21	1.08
6	2.33	1.21	1.17
7	2.13	1.46	1.29
8	2.00	1.63	1.38
9	2.00	1.92	1.33
10	2.08	1.92	1.25
11	2.08	2.21	1.31
12	2.08	2.08	1.21
13	2.00	2.17	1.21
14	2.00	2.13	1.00
15	2.37	2.08	1.17
16	1.37	2.13	1.19
17	1.36	2.10	2.10

July 17, 2003 - Deep Wells

Table 19. Ground water levels (DWT in feet) measured in Kirton Ranch deep wells on July 17, 2003.

Plot	Row A DWT(10-ft)	Row B DWT(10-ft)	Row C DWT(10-ft)
1	3.08	3.17	2.71
2	3.10	3.10	2.44
3	3.17	3.08	2.63
4	3.15	3.13	2.77
5	3.00	3.09	2.77
6	3.19	3.02	2.83
7	2.96	3.19	2.92
8	2.92	2.96	3.90
9	2.94	2.88	3.92
10	3.00	2.92	2.88
11	2.96	2.85	3.00
12	3.06	2.79	2.90
13	2.94	2.67	2.92
14	2.96	2.69	2.88
15	3.08	2.94	2.77
16	2.92	2.79	2.83
17	3.06	2.96	2.83

Appendix 3
Ground Water Physical Parameters Summary

March 19, 2003 - Deep and Shallow Wells

Table 20. pH measured in Kirton Ranch shallow and deep wells on March 19, 2003.

PLOT	ROW A		ROW B		ROW C	
	pH shallow (3-ft)	pH deep (10-ft)	pH shallow (3-ft)	pH deep (10-ft)	pH shallow (3-ft)	pH deep (10-ft)
1	5.63	5.24	5.84	5.20	5.31	5.25
2	6.04	5.50	5.86	5.76	5.43	4.90
3	5.47	4.96	5.40	5.26	6.07	5.71
4	5.81	5.71	5.95	5.13	5.67	5.99
5	6.00	4.14	5.66	5.38	4.84	5.71
6	5.08	4.63	5.94	5.66	4.80	4.52
7	5.54	4.80	5.53	5.61	5.84	5.69
8	5.51	4.55	5.34	4.74	5.75	6.57
9	4.82	5.13	5.40	5.71	6.13	5.93
10	4.65	1.48	6.01	5.50	6.50	5.96
11	4.97	4.79	5.08	4.84	4.44	6.30
12	5.37	4.05	5.03	5.16	4.82	4.03
13	4.93	5.37	4.57	4.05	5.36	5.34
14	5.09	5.44	4.90	4.93	5.31	5.06
15	5.23	4.88	5.10	5.43	4.70	4.97
16	5.11	4.94	4.46	4.10	5.75	5.78
17	4.73	4.66	5.05	5.01	4.64	5.13

Table 21. Conductivity (µS) measured in Kirton Ranch shallow and deep wells on March 19, 2003.

PLOT	ROW A		ROW B		ROW C	
	Cond.(µS) shallow (3-ft)	Cond. (µS) deep (10-ft)	Cond.(µS) shallow (3-ft)	Cond. (µS) deep (10-ft)	Cond.(µS) shallow (3-ft)	Cond. (µS) deep (10-ft)
1	230	177	227	225	206	177
2	173	181	186	321	273	246
3	173	110	165	302	228	248
4	138	153	375	589	131	307
5	138	164	254	325	105	191
6	127	174	182	80	99	198
7	157	152	80	183	99	177
8	126	258	139	115	105	308
9	123	254	127	233	203	373
10	169	191	180	238	355	214
11	100	128	106	181	254	144
12	137	187	103	136	168	148
13	89	244	81	163	244	328
14	64	194	107	113	148	192
15	111	179	122	117	65	201
16	128	124	105	121	133	218
17	116	200	69	125	90	173

June 13, 2003 - Deep Wells

Table 22. pH measured in Kirton Ranch deep wells on June 13, 2003.

Plot	Row A pH	Row B pH	Row C pH
1	4.83	4.44	4.31
2	4.48	5.16	4.18
3	3.87	5.20	5.82
4	4.49	4.53	5.48
5	3.31	4.74	5.54
6	4.03	5.11	4.12
7	4.02	5.15	5.38
8	3.48	4.08	5.79
9	4.47	5.16	6.04
10	4.24	4.72	4.33
11	4.37	4.10	5.15
12	3.67	4.84	4.44
13	4.92	3.34	4.81
14	5.38	4.30	4.41
15	3.98	4.86	4.30
16	4.23	3.50	5.31
17	3.96	4.93	4.33

Table 23. Conductivity (µS) measured in Kirton Ranch deep wells on June 13, 2003.

Plot	Row A Conductivity	Row B Conductivity	Row C Conductivity
1	193	271	184
2	199	297	164
3	154	312	382
4	160	577	290
5	153	337	198
6	198	303	178
7	186	242	-
8	291	147	252
9	216	198	321
10	196	219	-
11	154	167	-
12	144	168	-
13	214	152	-
14	193	140	-
15	191	101	-
16	133	181	-
17	180	191	-

Comments: Missing values due to failure in instrument system (bad sensor cable).

Table 24. Temperature (°C) measured in Kirton Ranch deep wells on June 13, 2003..

Plot	Row A Temperature	Row B Temperature	Row C Temperature
1	26.6	25.3	27.0
2	26.9	25.4	26.4
3	26.2	25.6	25.7
4	25.6	25.6	25.2
5	25.8	24.6	25.6
6	26.8	24.8	25.7
7	27.9	25.1	23.6
8	26.7	25.2	24.4
9	26.3	24.7	25.0
10	26.2	25.0	25.0
11	26.3	24.7	-
12	26.0	25.3	-
13	25.9	25.4	-
14	25.6	25.6	-
15	25.6	26.0	-
16	25.6	25.9	-
17	25.1	26.3	-

Comments: Missing values due to failure in instrument system (bad sensor cable).

June 24, 2003 - Shallow Wells

Table 25. pH measured in Kirton Ranch shallow wells on June 24, 2003.

Plot	Row A pH	Row B pH	Row C pH
1	4.82	5.13	5.31
2	5.34	5.66	5.78
3	5.25	4.96	6.36
4	5.22	5.64	5.74
5	5.67	5.68	4.97
6	4.97	5.52	4.58
7	5.81	5.74	5.31
8	5.44	5.51	5.62
9	5.57	5.09	5.64
10	4.41	5.91	6.55
11	5.27	5.05	5.40
12	5.80	4.69	4.99
13	5.25	4.32	4.96
14	5.41	4.67	5.69
15	5.81	5.08	5.56
16	5.14	4.08	5.72
17	4.85	5.03	5.61

Table 26. Conductivity (µS) measured in Kirton Ranch shallow wells on June 24, 2003.

Plot	Row A Conductivity	Row B Conductivity	Row C Conductivity
1	302	425	158
2	240	536	223
3	199	105	276
4	207	196	163
5	260	223	65
6	246	126	210
7	440	139	222
8	196	164	162
9	195	105	374
10	181	186	459
11	226	98	182
12	284	213	181
13	207	97	191
14	197	141	179
15	208	120	169
16	195	182	231
17	118	118	133

Table 27. Temperature (°C) measured in Kirton Ranch shallow wells on June 24, 2003.

Plot	Row A Temperature	Row B Temperature	Row C Temperature
1	27.0	26.5	26.4
2	27.6	26.4	26.8
3	26.9	25.9	26.7
4	26.8	26.0	26.8
5	27.0	25.8	26.3
6	27.1	26.3	26.3
7	26.8	26.1	26.4
8	26.8	26.4	26.5
9	27.3	26.4	26.2
10	26.7	27.2	26.3
11	27.4	28.0	26.4
12	27.4	26.7	26.5
13	27.0	26.8	26.4
14	26.9	26.4	26.5
15	27.3	26.5	26.2
16	27.1	27.2	26.2
17	27.2	27.6	26.4

June 27, 2003 - Deep Wells

Table 28. pH measured in Kirton Ranch deep wells on June 27, 2003.

Plot	Row A pH	Row B pH	Row C pH
1	4.58	4.44	4.25
2	4.25	5.11	4.30
3	4.04	6.35	5.20
4	4.78	4.61	5.50
5	3.51	4.69	5.43
6	4.20	5.00	4.19
7	3.98	5.20	5.40
8	3.70	4.20	5.89
9	4.44	5.27	5.82
10	4.13	4.79	5.52
11	4.42	4.14	5.02
12	3.68	4.85	4.30
13	5.07	3.54	4.02
14	5.55	4.24	4.36
15	4.38	4.95	4.33
16	4.41	3.58	5.24
17	4.37	5.03	4.45

Table 29. Conductivity (µS) measured in Kirton Ranch deep wells on June 27, 2003.

Plot	Row A Conductivity	Row B Conductivity	Row C Conductivity
1	217	242	152
2	164	320	246
3	133	301	247
4	114	590	310
5	112	377	258
6	168	276	206
7	164	241	251
8	331	103	293
9	234	192	342
10	172	200	183
11	140	124	167
12	126	190	138
13	223	126	302
14	172	87	179
15	137	88	196
16	108	125	143
17	-	118	110

Table 30. Temperature (°C) measured in Kirton Ranch deep wells on June 27, 2003.

Plot	Row A Temperature	Row B Temperature	Row C Temperature
1	27.8	25.6	25.7
2	27.3	25.5	25.2
3	26.7	25.4	25.4
4	27.2	25.5	25.2
5	27.0	25.4	25.2
6	27.2	25.4	25.4
7	27.2	25.7	25.4
8	27.0	25.9	25.2
9	27.3	25.2	25.6
10	26.9	25.4	25.7
11	26.6	25.5	25.2
12	26.6	25.6	25.3
13	26.4.	25.8	25.1
14	26.7	25.4	25.2
15	27.0	25.2	25.2
16	27.0	25.7	25.5
17	26.8	26.0	26.6

July 17, 2003 - Deep Wells

Table 31. pH measured in Kirton Ranch deep wells on July 17, 2003.

Plot	Row A pH	Row B pH	Row C pH
1	4.63	4.52	4.23
2	4.15	5.20	4.23
3	3.80	5.35	5.59
4	4.46	4.74	5.47
5	3.41	4.81	5.01
6	3.97	5.26	4.89
7	3.91	4.92	5.33
8	3.61	4.14	4.89
9	4.50	5.25	5.87
10	4.04	4.89	4.92
11	4.34	4.35	4.90
12	3.60	4.63	4.89
13	5.08	3.62	3.0
14	5.46	4.08	4.89
15	4.25	4.83	4.89
16	4.48	3.63	4.91
17	4.10	4.41	4.91

Table 32. Conductivity (µS) measured in Kirton Ranch deep wells on July 17, 2003.

Plot	Row A Conductivity	Row B Conductivity	Row C Conductivity
1	231	281	281
2	239	338	338
3	180	371	371
4	160	750	750
5	192	389	389
6	199	336	336
7	196	192	192
8	370	147	147
9	280	248	248
10	223	253	253
11	162	189	189
12	168	243	243
13	275	270	270
14	228	169	169
15	176	112	112
16	142	178	178
17	216	281	137

Table 33. Temperature (°C) measured in Kirton Ranch deep wells on July 17, 2003.

Plot	Row A Temperature	Row B Temperature	Row C Temperature
1	27.3	26.9	27.1
2	26.9	26.2	26.6
3	26.8	26.4	26.4
4	26.4	26.7	26.0
5	26.5	27.0	25.9
6	26.3	26.7	26.2
7	26.8	26.3	26.4
8	26.2	25.9	26.2
9	26.3	26.4	26.8
10	26.3	26.7	27.6
11	26.3	26.7	25.9
12	26.2	26.2	26.0
13	26.3	26.0	25.9
14	26.3	26.0	26.6
15	26.6	26.7	27.0
16	26.3	26.0	27.4
17	26.1	26.1	26.9

Appendix 4
Ground Water Parameter Contour Maps

These map figures are provided to assist in visualization of ground water spatial trends across the demonstration project plots.

March 19, 2003

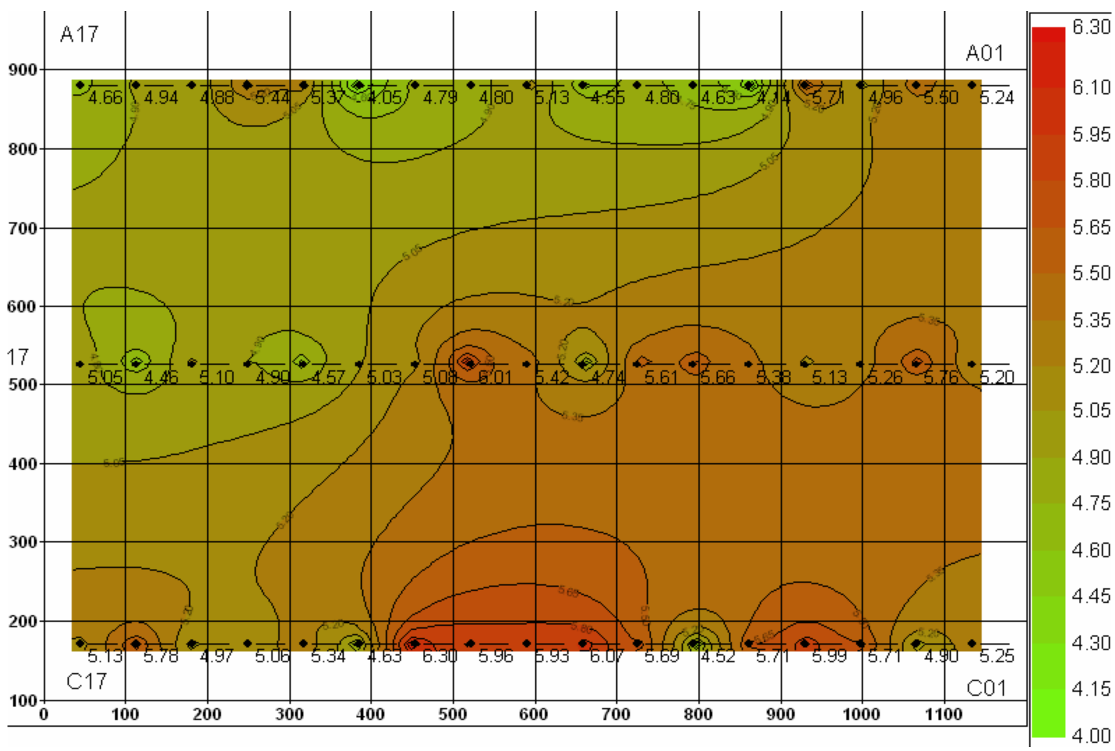

Figure 1. Contour map of pH in the Kirton Ranch deep wells on March 19, 2003.

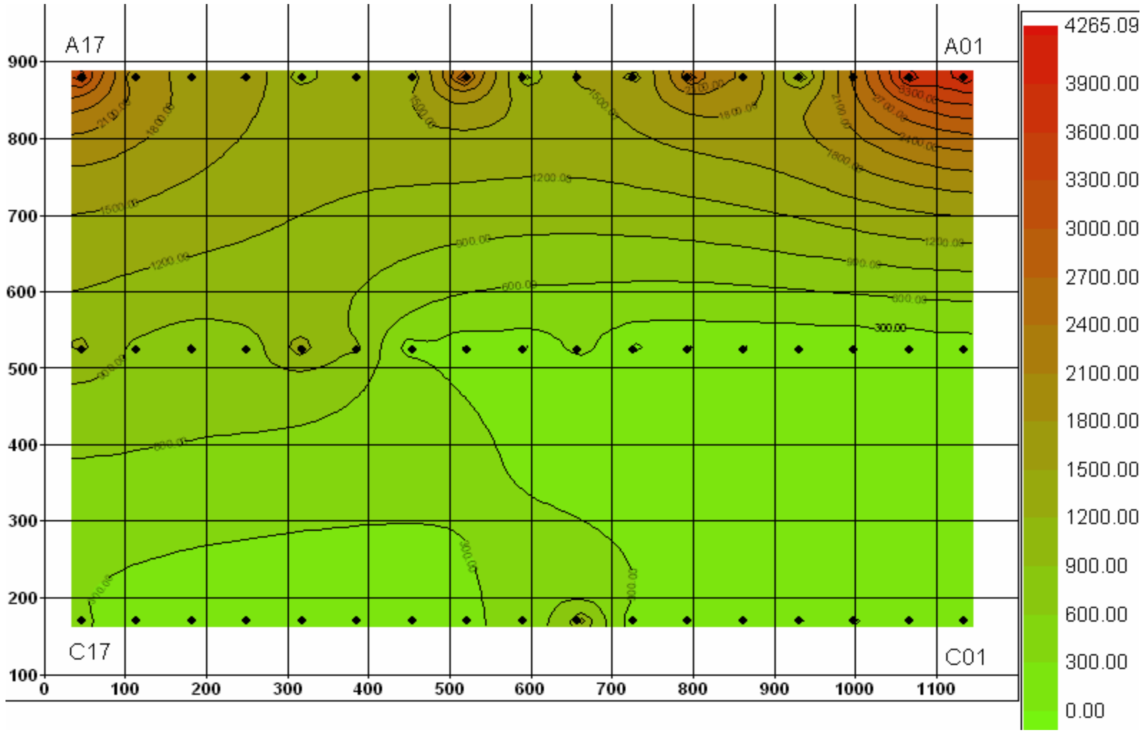

Figure 2. Contour map of TDPO4 concentrations in the Kirton Ranch deep wells on March 19, 2003.

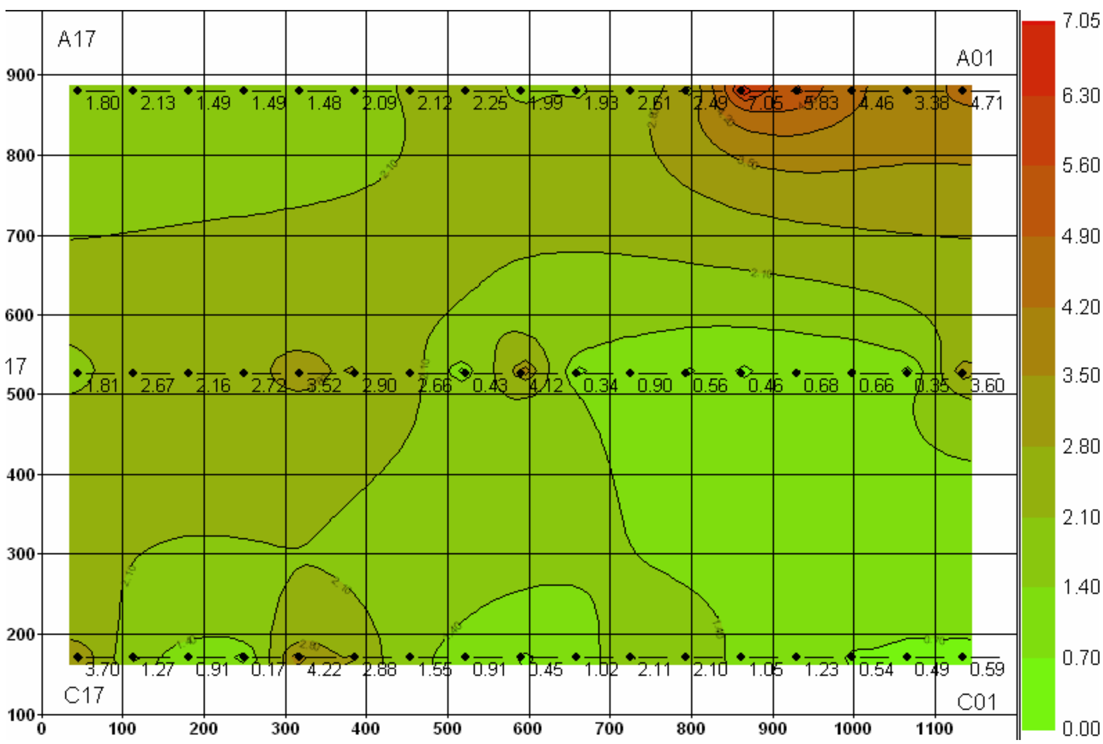

Figure 3. Contour map of Total Al concentrations in the Kirton Ranch deep wells on March 19, 2003.

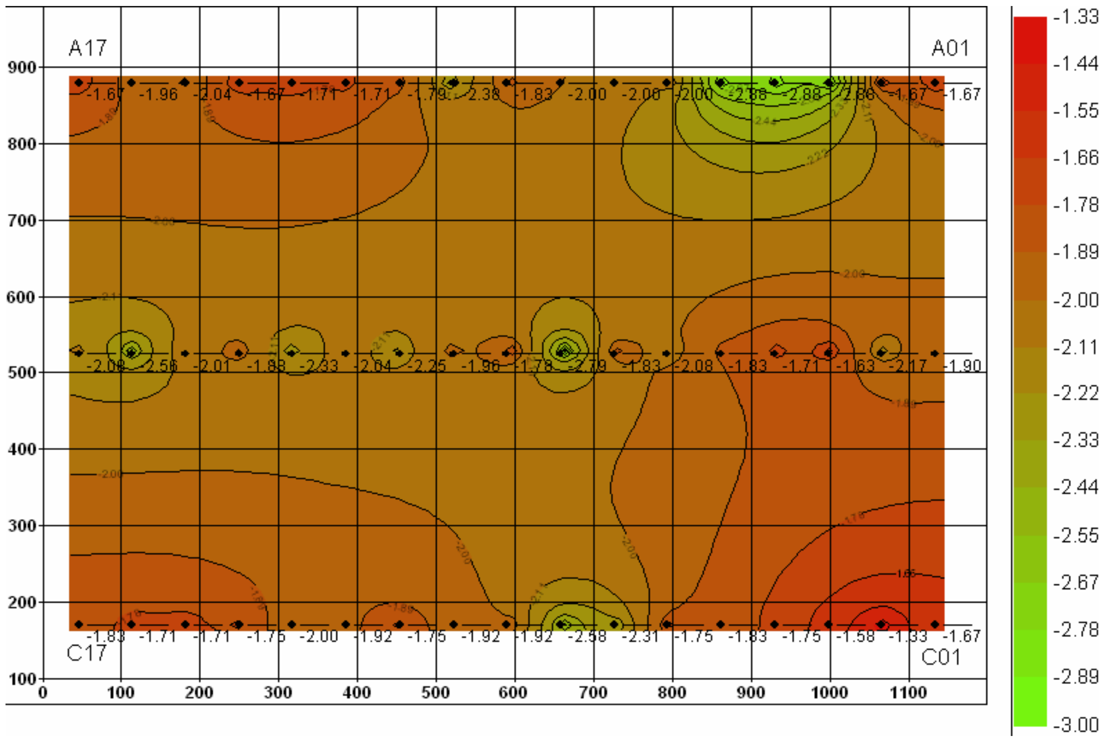

Figure 4. Contour map of DWT (Depth of water table) in the Kirton Ranch deep wells on March 19, 2003.

June 13, 2003

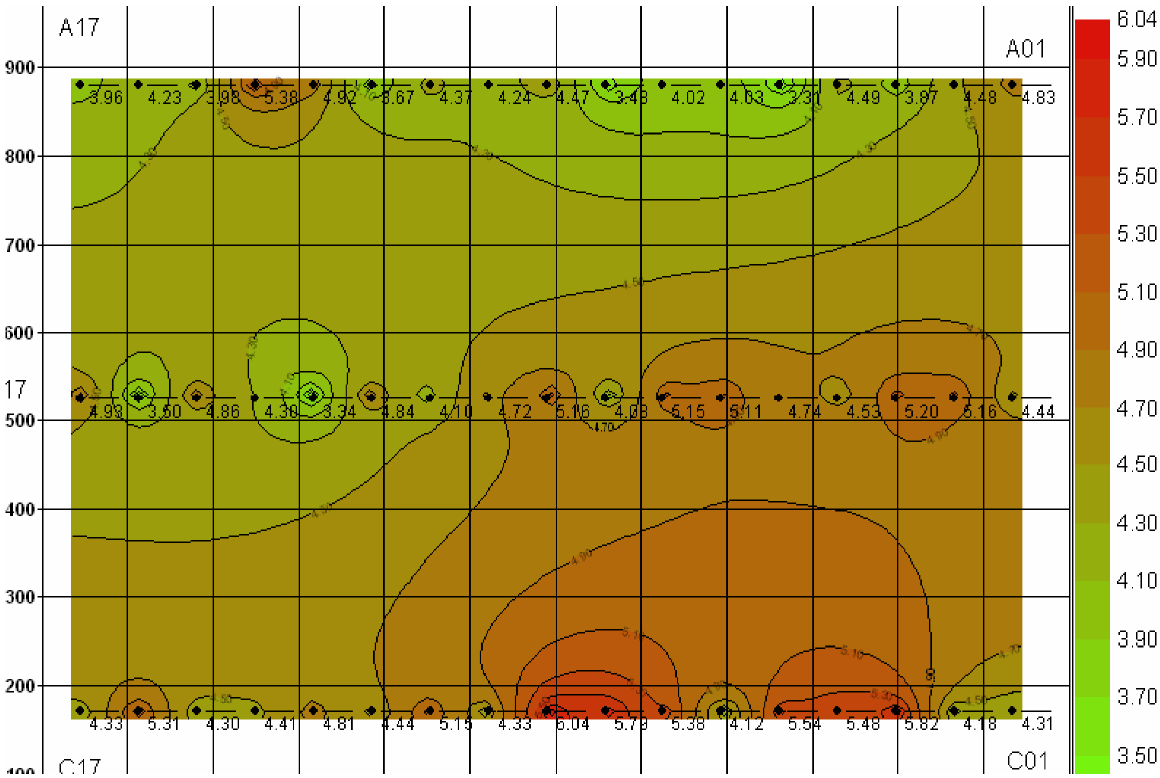

Figure 5. Contour map of pH in the Kirton Ranch deep wells on June 13, 2003.

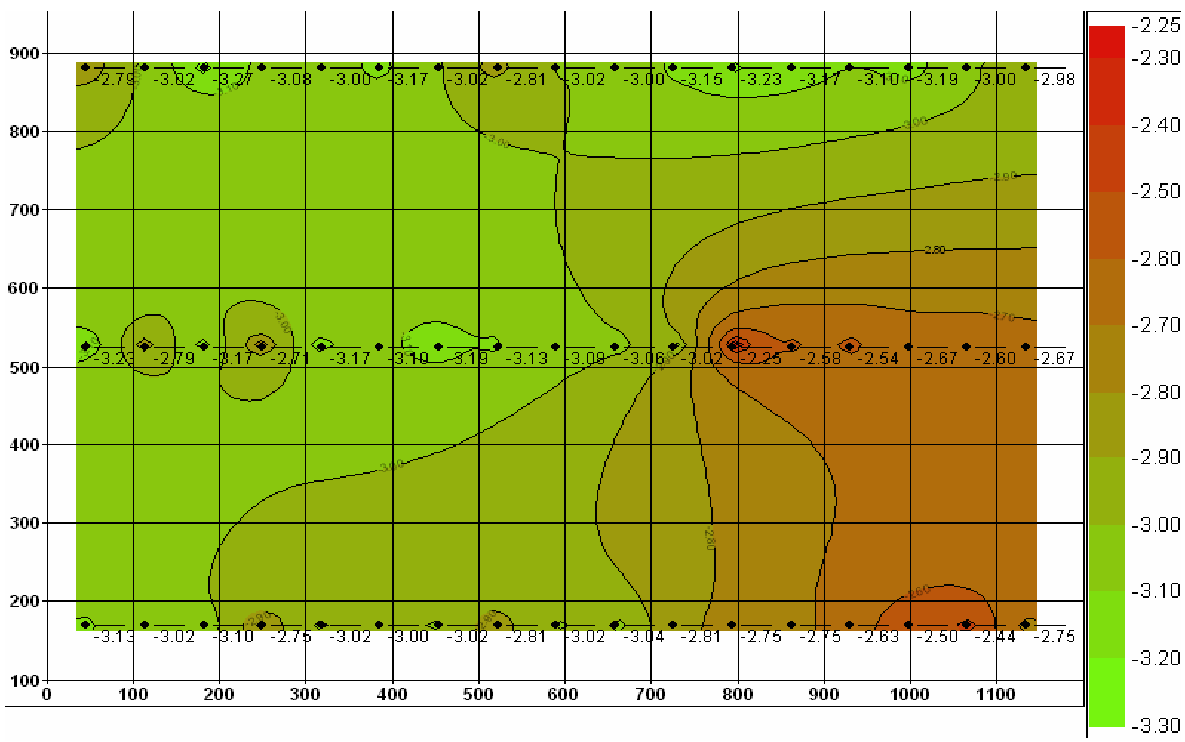

Figure 6. Contour map of DWT in the Kirton Ranch deep wells on June 13, 2003.

June 27, 2003

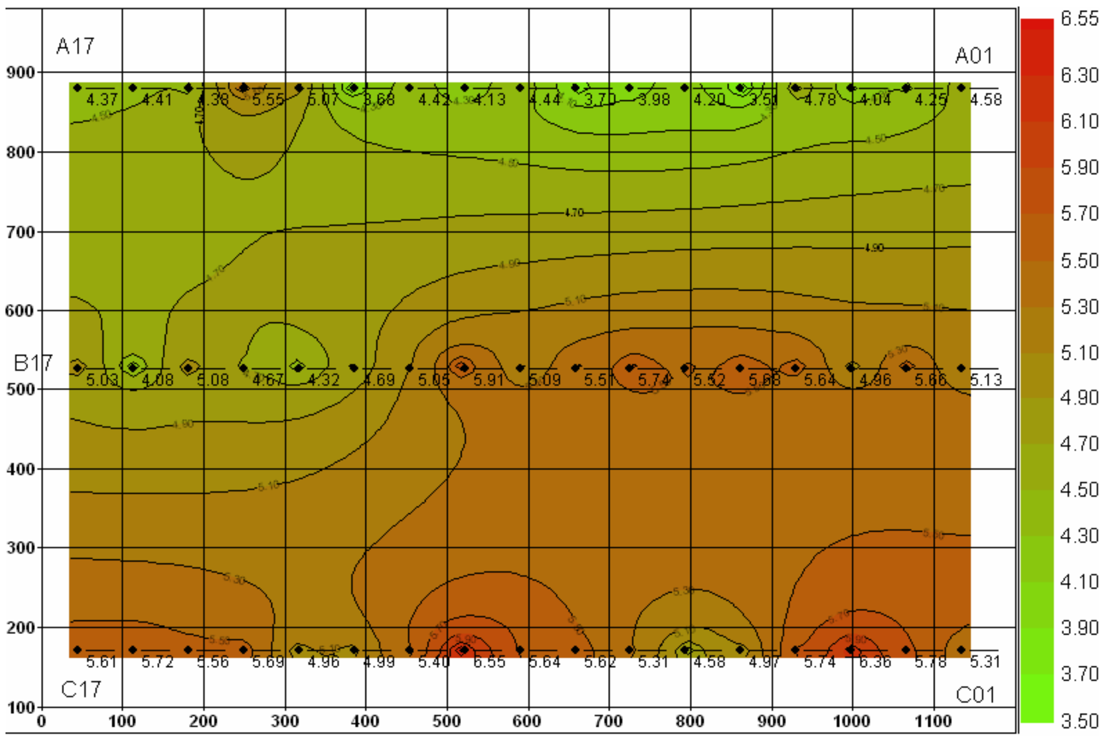

Figure 7. Contour map of pH map in the Kirton Ranch deep wells on June 27, 2003.

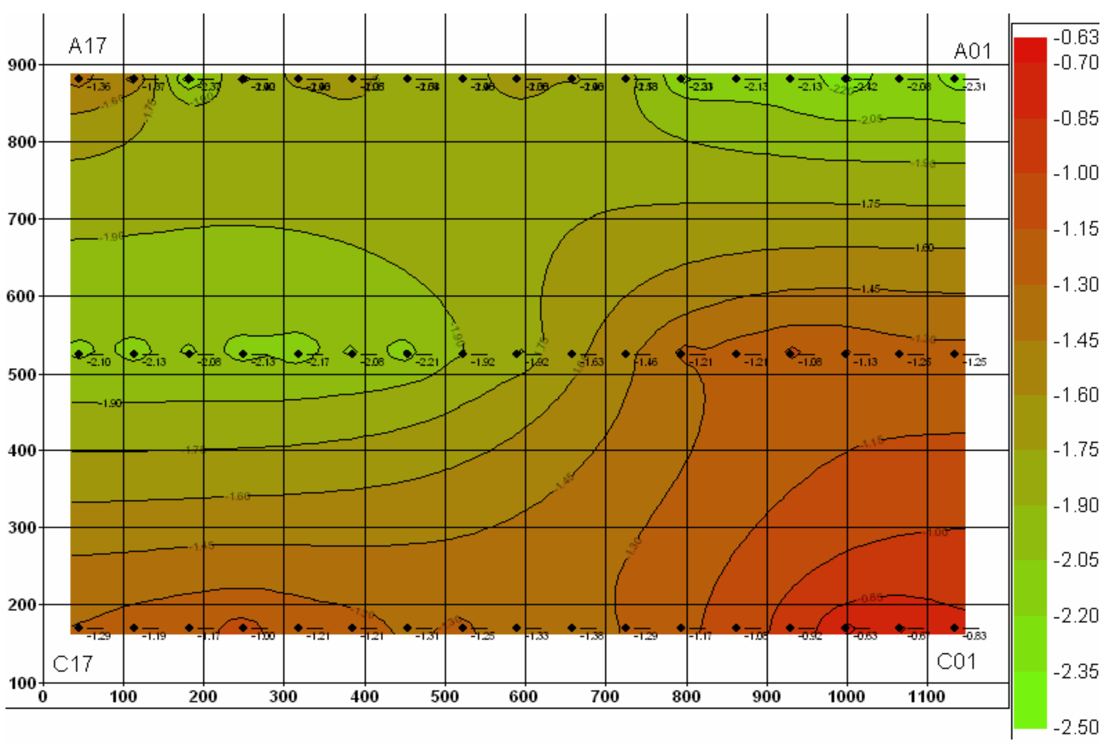

Figure 8. Contour map of DWT in the Kirton Ranch deep wells on June 27, 2003.

July 17, 2003

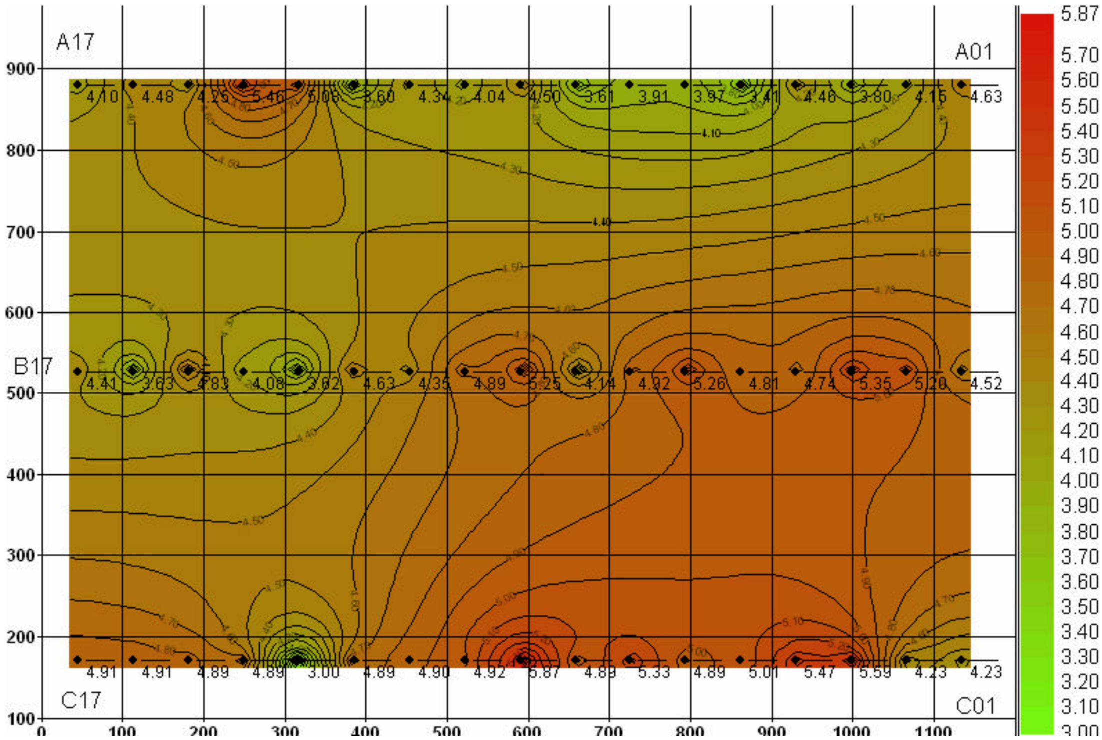

Figure 9. Contour map of pH in the Kirton Ranch deep wells on July 17, 2003.

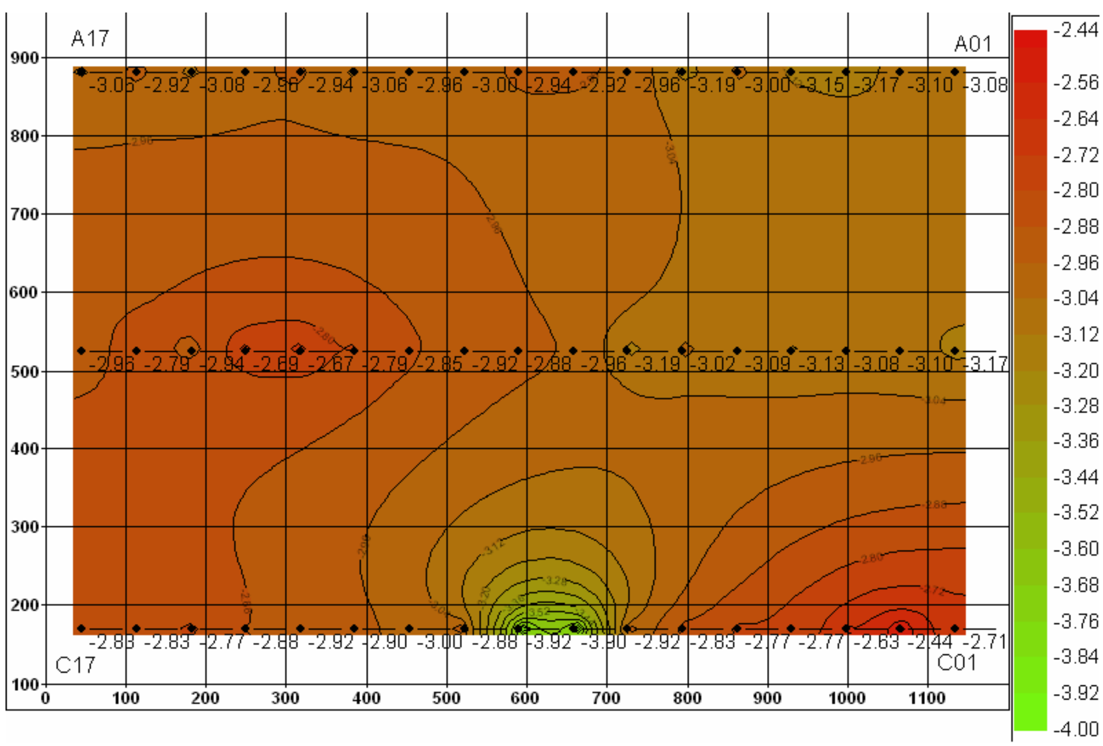

Figure 10. Contour map of DWT in the Kirton Ranch deep wells on July 17, 2003.